HEWLETT PACKARD

Operating
and
Service
Manual

Model 410C
Electronic Voltmeter

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 410C
ELECTRONIC VOLTMETER

Serials Numbers: 0982A22339 and Above

NOTICE

For those instruments with serial numbers 0982A22338 and below, refer to Manual Part No. 00410-90007.

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excessive moisture.

Manual Part No. 00410-90009

Microfiche Part No. 00410-90059

P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

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HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

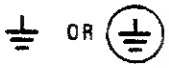
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

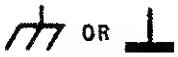
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 410C Electronic Voltmeter can be used to measure dc voltage, dc current, ac voltage, and resistance. Positive and negative dc voltages from 15 mV to 1500 V full scale and positive and negative dc currents from 1.5 μA to 150 mA full scale can be measured. Resistance from 10 Ω to 10 MΩ mid-scale can be measured with an accuracy of ± 5%; resistance from 0.2 Ω to 500 MΩ can be measured with reduced accuracy. The Model 410C Electronic Voltmeter specifications are given in Table 1-1.

1-3. With the Model 11036A detachable AC Probe, the Voltmeter can be used to measure ac voltage from 20 Hz to 700 MHz. AC Voltages from 0.5 to 300 V can be measured in the 20 Hz to 100 MHz range. Refer to Figure 3-5 for maximum voltage that can be applied to the AC Probe for the 100 MHz to 700 MHz range. For additional information on the AC Probe, refer to Paragraph 1-9.

1-4. INSTRUMENT AND MANUAL IDENTIFICATION.

1-5. Hewlett-Packard uses a two-section serial number consisting of a digit prefix and a five-digit suffix. The prefix and suffix are separated by a letter designating the country in which the instrument was manufactured. (A = U.S.A.; G = Germany; J = Japan; U = United Kingdom.)

1-6. This manual applies to instruments with the serial prefix indicated on the title page. If changes have been made in the instrument since the printing of this manual, a "Manual Changes" supplement supplied with the manual will define these changes. Be sure to record these changes in your manual. Backdating information located in Appendix C adapts the manual to instruments manufactured prior to this printing. The manual part number is indicated on the title page.

1-7. ACCESSORIES AVAILABLE.

1-8. Accessories are available that extend the ac and dc measuring capabilities of the Voltmeter. A description of these accessories and their specifications is given below.

1-9. Model 11036A AC Probe.

1-10. This accessory, when used with the Model 410C, permits ac voltage measurements over a frequency range of 20 Hz to 700 MHz. Refer to Figure 3-5 for the maximum RMS voltages that can be applied to the AC Probe in this frequency range. Reference calibration accuracy at 400 Hz (sinusoidal) is ± 3% of full scale. Frequency response is ± 10% from 20 Hz to 700 MHz, with indications obtainable to 3000 MHz. Frequency response at 100 MHz is within ± .2%. The Model 11036A responds to the positive-peak-above-average value of the signal applied. The Model 410C is calibrated to read in RMS volts, for sine wave inputs.

1-11. Model 11040A Capacity Divider.

1-12. This accessory (formerly the Model 453A) extends the ac voltage range of the Voltmeter to 2000 V rms. The divider is for use at frequencies above 10 kHz. Voltage division is 100:1 ± 1%, and input capacity is approximately 2 pF.

1-13. Model 11042A Probe T Connector.

1-14. This accessory (formerly the Model 455A) is used for connecting the Model 11036A Probe across a 50 Ω transmission line using type N connectors. The T joint is such that connection of the probe into a transmission line will not cause a standing wave ratio greater than 1.1 at 500 MHz and 1.2 at 1000 MHz. With this device, measurement of power traveling through a transmission line may be made with reasonable accuracy to 1000 MHz. The usual precautions must be taken to provide accurate impedance matching and the elimination of standing waves along the line through which power is floating. By using a dummy load at the receiving end of this T joint power output of various devices can be measured. In many applications power going into a real load, such as an antenna, can be conveniently measured up to 1000 MHz with good accuracy.

1-15. Model 11043A Type N Connector.

1-16. This accessory (formerly the Model 458A) allows the AC Probe to be connected to a 50 Ω coaxial line. The connector uses a male type N connector and a receptacle for receiving the probe. Terminating resistor is not included.

1-17. Model 11045A DC Divider.

1-18. This accessory extends the maximum dc voltage range of the Model 410C to 30 kV. Voltage division is 100:1, ± 5%, and input resistance is 9900 MΩ. When

used with the Model 410C input resistance is 10,000 MΩ. This probe offers maximum safety and convenience for measuring high voltages such as in television equipment, etc. The maximum current drain is 2.5 μA.

Table 1-1. Specifications.

DC VOLTMETER

Voltage Ranges: 15 mV to ± 1500 V full scale in 0.5, 1.5, 5 sequence (11 ranges).

Accuracy: ± 2% of full scale on any range.

Input Resistance: 100 MΩ ± 1% of 500 mV range and above. 10 MΩ ± 3% on 15 mV, 50 mV, and 150 mV ranges.

DC AMMETER

Current Ranges: ± 1.5 μA to ± 150 mA full scale in 1.5, 5 sequence (11 ranges).

Accuracy: ± 3% of full scale on any range.

Input Resistance: Decreasing from 9 kΩ on 1.5 μA scale to approximately 0.3 Ω on the 150 mA scale.

Special Current Ranges: ± 1.5, ± 5, ± 15 nanoamps may be measured on the 15, 50, and 150 millivolt ranges using the voltmeter probe, with ± 5% accuracy and 10 MΩ input resistance.

OHMMETER

Resistance Range: Resistance from 10 Ω to 10 MΩ center scale (7 ranges).

Accuracy: Zero to midscale: ± 5% of reading or ± 2% of midscale, whichever is greater.
± 7% of reading from midscale value of 2.
± 8% of reading from scale value of 2 to 3.
± 9% of reading from scale value of 3 to 5.
± 10% of reading from scale value of 5 to 10.

AMPLIFIER

Voltage Gain: 100 minimum.

AC Rejection: 3 dB at ½ Hz; approximately 68 dB at 50 Hz and higher frequencies for signals less than 1800 V peak or 30 times full scale, whichever is smaller.

Isolation: Impedance between common and chassis is > 10 MΩ in parallel with 0.1 μF. Common maybe floated up to 400 V dc above chassis for dc and resistance measurements.

Output: Proportional to meter indication; 1.5 V dc at full scale, maximum current, 1 mA.

Output Impedance: Less than 3 Ω at dc.

Noise: Less than 0.5% of full scale on any range (p - p).

DC Drift: Less than 0.5% of full scale/year at constant temperature. Less than .05% of full scale/°C.

Overload Recovery: Recover from 100:1 overload in < 3 sec.

AC VOLTMETER

Ranges: 0.5 V full scale to 300 V in 0.5, 1.5, 5 sequence (7 ranges).

Accuracy: ± 3% of full scale at 400 Hz for sinusoidal voltages from 0.5 to 300 V rms. The AC Probe responds to the positive peak-above-average value of the applied signal.

Frequency Response: ± 2% from 100 Hz to 50 MHz (400 Hz ref.), ± 4% from 50 MHz to 100 MHz ± 10% from 20 Hz to 100 Hz and ± 1.5 dB from 100 MHz to to 700 MHz.

Frequency Range: 20 Hz to 700 MHz.

Input Impedance: Input capacity 1.5 pF, input resistance > 10 MΩ at low frequencies. At high frequencies impedance drops off due to dielectric loss.

Safety: The probe body is grounded to chassis in the AC Function for safety. All ac measurements are referenced to chassis ground.

Meter: Individually calibrated test band meter. Responds to positive peak-above-average. Calibrated in rms volts for sine wave input.

GENERAL

Maximum Input: (see Overload Recovery)
DC: 100 V on 15, 50 and 150 mV ranges; 500 V on 0.5 to 15 V ranges; 1800 V on higher ranges.
AC: 100 times full scale or 450 V peak, whichever is less.

Power: 115 or 230 V ± 10%, 48 to 440 Hz, 10 watts (17 watts with 11038A AC Probe).

Dimensions: 8½ in. high (18.5 cm); 5 1/8 in. wide (13.01 cm); 11 in. deep (27.9 cm) behind panel. Fits 5060-0787 Rack Adapter and 1050 series combining cases.

Weight:
Net: 7.5 lbs. (3.4 kg)
Shipping: approximately 14.5 lbs. (6.58 kg)

Accessories Furnished: Detachable power cord, NEMA plug; -hp- Model 11036A AC Probe.

Option 002: -hp- Model 410C less AC Probe.

SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically, before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also, check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5, Performance Tests. If there is damage or deficiency, see the warranty on the page following the title page of this manual.

2-3. INSTALLATION.

2-4. The -hp- Model 410C is solid state and requires no special cooling. However, the instrument should not be operated where the ambient temperature exceeds 55°C (140°F).

2-5. RACK MOUNTING.

2-6. The Model 410C is a submodular unit designed for bench use. However, when used in combination with other submodular units, it can be bench and/or rack mounted. The -hp- Combining Cases and Adapter Frame are designed specifically for this purpose.

2-7. Models 1051A and 1052A Combining Cases.

2-8. The Combining Cases are full-module units which accept various combinations of submodular units. Being a full width unit, it can either be bench or rack mounted. An illustration of the Combining Case is shown in Figure 2-1. Instructions for installing the Model 410C are shown in Figure 2-2.

2-9. Rack Adapter Frame (-hp- Part Number 5060-8762).

2-10. The adapter frame is a rack mounting frame that accepts various combinations of submodular units. It can be rack mounted only. An illustration of the adapter frame is given in Figure 2-3. Instructions are given below.

a. Place the adapter frame on edge of bench as shown in step 1, Figure 2-4.

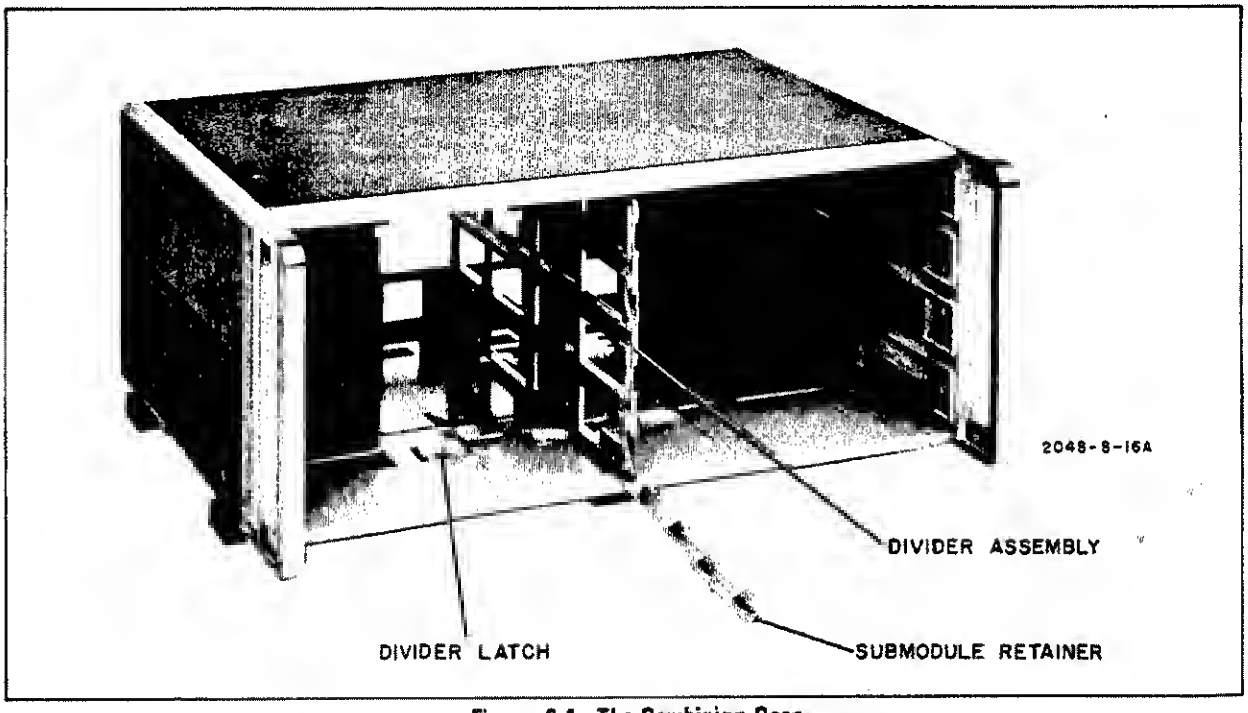


Figure 2-1. The Combining Case.

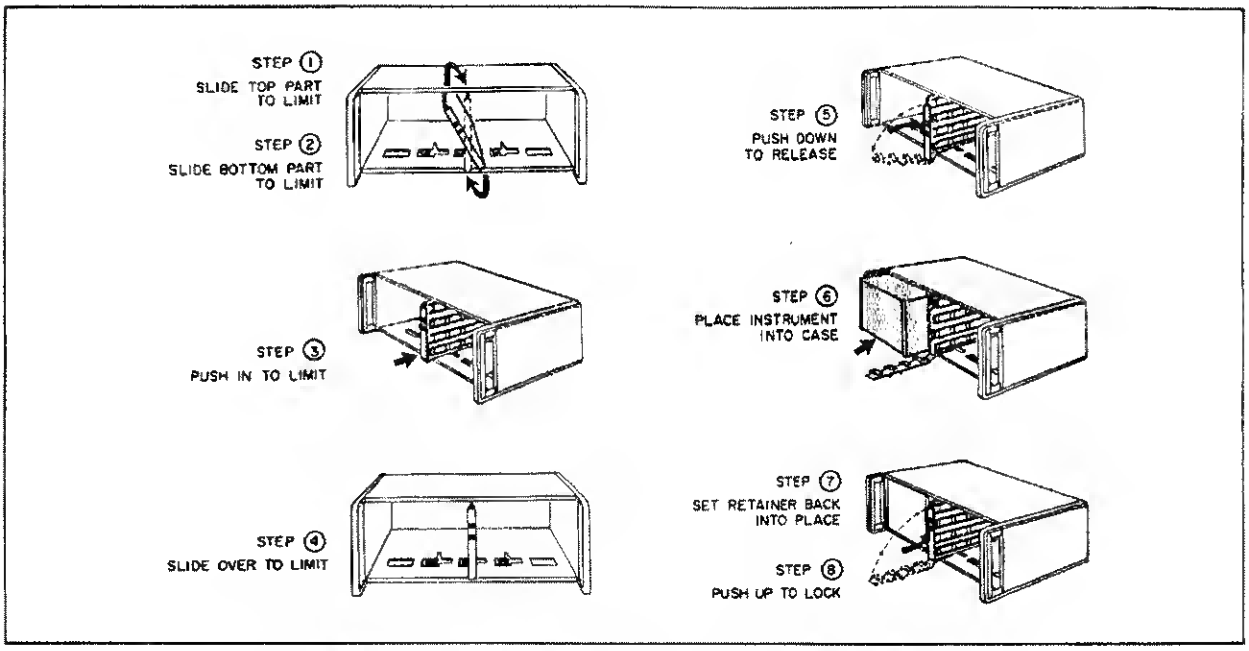


Figure 2-2. Steps to Place Instrument in Combining Case.

b. Stack the submodular units in the frame as shown in step 2, Figure 2-4. Place the spacer clamps between instruments as shown in step 3., Figure 2-4.

c. Place spacer clamps on the two end instruments (see step 4, Figure 2-4) and push the combination into the frame.

d. Insert screws on either side of frame, and tighten until submodular instruments are tight in the frame.

e. The complete assembly is ready for rack mounting.

2-11. THREE-CONDUCTOR POWER CABLE.

WARNING

To protect operating personnel from electric shock, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three conductor power cable which grounds the instrument when plugged into an appropriate receptacle.

2-12. To preserve the protection feature when operating the instrument from a two-contact outlet, use three-prong to two-prong adapter and connect the green pigtail on the adapter to an adequate ground.

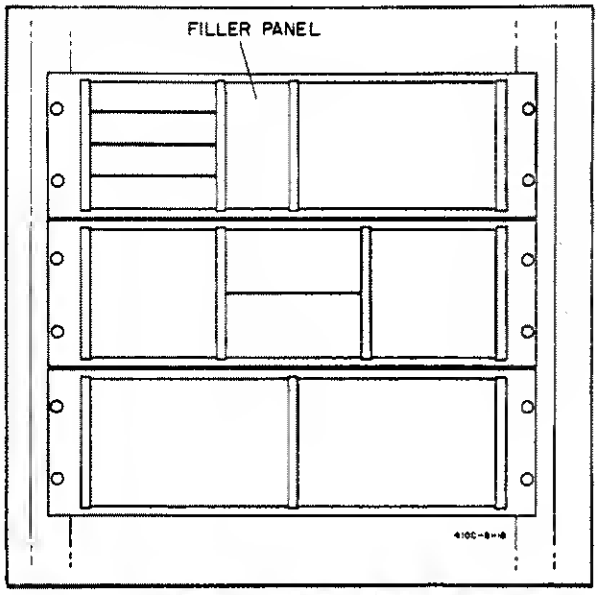


Figure 2-3. Adapter Frame Instrument Combination.

2-13. PRIMARY POWER REQUIREMENTS.

2-14. The Model 410C can be operated from either 115 or 230 V, 48 to 440 Hz. The instrument can be easily converted from 115 to 230 V operation. The SELECTOR switch, S2 a two-position slide switch located at the rear of the instrument, selects the mode of ac operation. The line voltage from which the instrument is set

to operate appears on the slider of the switch. A 0.25 ampere, slo-blo fuse is used for both 115 and 230 V operation.

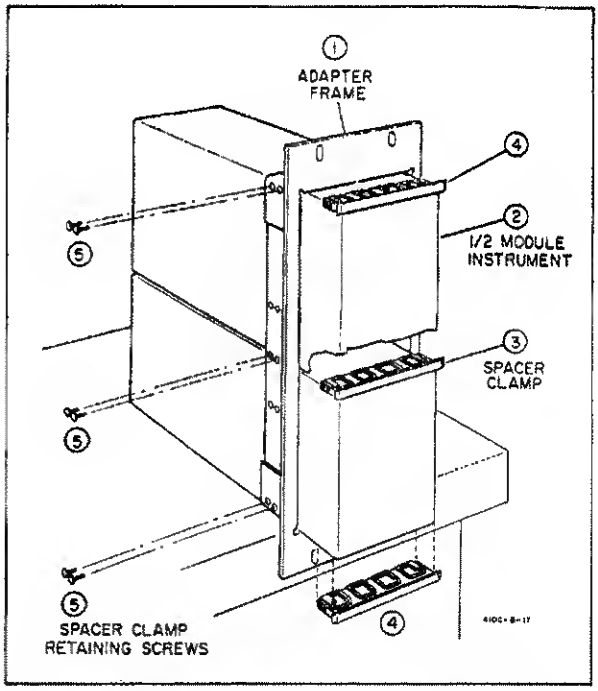


Figure 2-4. Two Half Modules in Rack Adapter.

CAUTION

Do not change the setting of the line voltage switch when the voltmeter is operating.

2-15. Repacking for Shipment.

2-16. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-17 if the original container is to be used; 2-18 if it is not. If you have any questions, contact your local -hp- Sales and Service Office (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be performed; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

2-17. If the original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that container is well sealed with strong tape or metal bands.

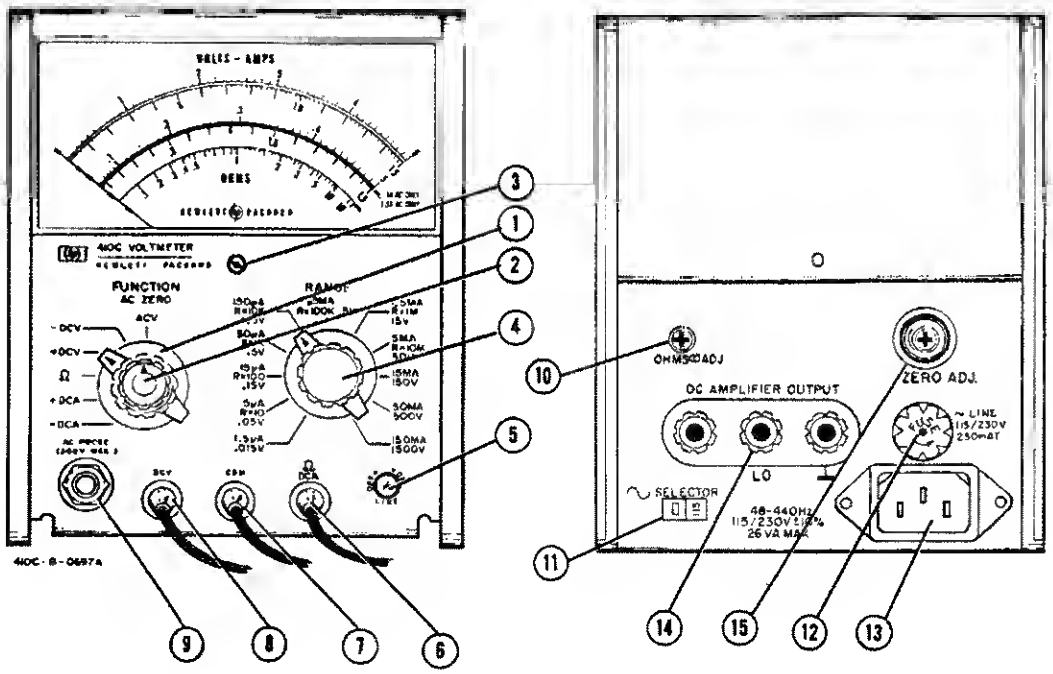
2-18. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE," etc.



(1) FUNCTION SELECTOR: Thie control is used for selecting type of measurement to be made. There are: ± DC Voltege, ± DC Current, AC Voltege, end resistence meesurements.

(2) AC ZERO: This control providee edjustment for zero-eetting the meter before making ac voltage meeeurements.

(3) MECHANICAL ZERO ADJUST: This edjustment mechanicelly zero-sets the meter prior to turning on Voltmeter.

(4) RANGE: This control selecte the full scele meter range.

(5) AC POWER SWITCH: This pushbutton-lamp combination, when depressed, turns the instrument power on or off. The pushbutton glows when the Voltmeter power is on.

(6) DCA-OHMS: This lead is used in conjunction with the COM Lead to meesure dc current or ohms. The FUNCTION SELECTOR determines which meesurement is made.

(7) COM: This lead is used with the input leads for dc current, dc voltege, end resistance measurements. The COM Leed is normally floeting; however, e shorting bar cen be connected from the floating ground terminal to the chessis ground terminal on the DC AMPLIFIER OUTPUT connector. If a shorting ber is not ueed, the COM Lead is floating except when the FUNCTION SELECTOR Is set to ACV.

(8) DCV: This lead is used in conjunction with the COM Lead to meeeure ± dc voltege.

(9) AC PROBE (300 V MAX): Receptecle for telephone-type plug of Model 11036A AC Probe. With probe connected, the Voltmeter may be used to meke ac voltage measuremente.

(10) ∞ ADJUST: Thie control is used to set meter pointer to ∞ before reeistence meesurements ere mede. Only periodic adjustment of this screwdriver adjustment ie necessary.

(11) LINE VOLTAGE: Thie two-position slide switch eets the instrument to eccept either 115 or 230 V ec primery power.

(12) FUSEHOLDER: The fuseholder conteine a 0.25 ampere slow-blow fuse for both 115 V ac end 230 V ec modes of operetion.

(13) AC POWER CONNECTOR: Accepts power ceble supplied with the instrument.

(14) DC AMPLIFIER OUTPUT: Provides dc voltege output proportionel to meter indication for driving external recorder. 1.5V dc output for full scale meter defisction.

(15) ZERO ADJUST: This control is used to set meter pointer to zero when calibreting for dc end resistance measurements.

NOTE

In some older 410C's there is no "zero adjust pot". It is however possible, to use pot A3R6 (see Figures 5-4 and 5-5) to set the meter pointer to zero. Pot A3R6 is located close to the top cover of the instrument and can be accessed with a small screwdriver. This note is only applicable if the new amplifier board 00410-66502 is retrofitted in an older 410C.

Figure 3-1. Front and Rear Panal Controls.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section presents operating instructions for using the -hp- Model 410C Analog Voltmeter. Refer to Figure 3-1 for the following discussion.

3-3. The 410C is capable of measuring dc voltages up to 1500 V dc, dc currents to 150 mA, and resistances up to 10 M (center of scale). Also, ac voltages of up to 300 V ac can be measured by using the 11036A AC PROBE.

3-4. FRONT AND REAR PANEL DESCRIPTION.

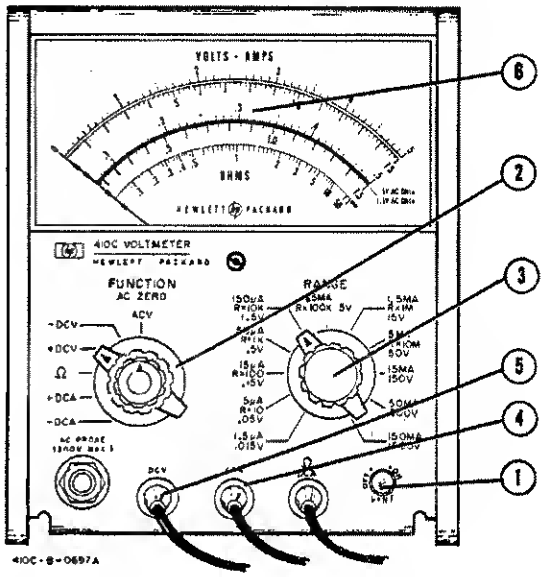
3-5. Figure 3-1 contains a brief description and a location layout of the front and rear panel controls and connectors.

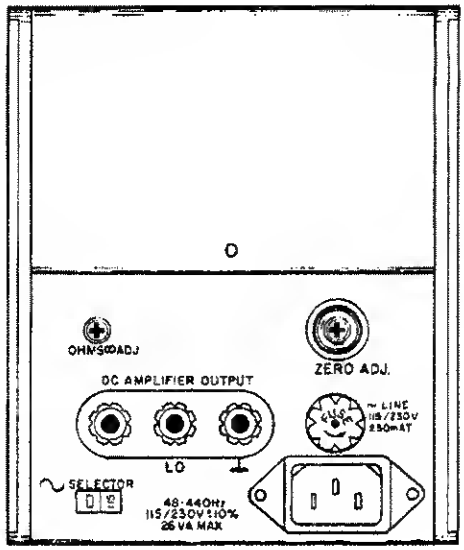
3-6. OPERATING PROCEDURES.

3-7. Before operating the 410C from the AC line verify that the line voltage selector switch, located on the rear panel of the instrument, is matched to the line voltage being used. Proceed to apply power. Turn the instrument on by depressing the ac power switch. The ac power switch will glow internally when the voltmeter power is on. If ac voltage measurements are to be made, plug the Model 11036A AC PROBE assembly into the AC PROBE receptacle (instrument front panel) and allow a minimum of five minutes warmup time.

3-8. DC Voltage Measurements.

3-9. Instructions for measuring dc voltages are given in Figure 3-2.





(1) Depress the AC power switch (lamp - switch combination).

(2) Set FUNCTION SELECTOR to polarity desired (+DCV or -DCV).

(3) Set RANGE to desired voltage position.

(4) Connect COM Lead to the ground of circuit under test.

(5) Touch DCV probe to test point.

(6) Read voltage on the appropriate VOLTS-AMPS scale.

Figure 3-2. DC Voltage Measurements.

CAUTION

The COM lead of the Model 410C is normally floating. A shorting bar can be connected at the DC AMPLIFIER OUTPUT connector, on the instrument back panel, to connect the COM lead to earth ground. If the 410C is allowed to float, the COM lead must not be connected to voltages greater than 400 V dc.

3-10. DC Current Measurements.

3-11. General instructions for measuring dc current are given in Figure 3-3.

3-12. Measuring DC Nano-Ampere Currents.

3-13. The three most sensitive dc voltage measurement ranges may be used to measure dc nano-ampere currents. Figure 3-4 describes this operation.

3-14. Resistance Measurements.

3-15. The procedure for making resistance measurements is given in Figure 3-5.

3-16. Before making in-circuit resistance measurements be certain that power has been removed from the circuit under test. All capacitors should be discharged to eliminate residual voltages.

3-17. AC Voltage Measurements (Figure 3-6).

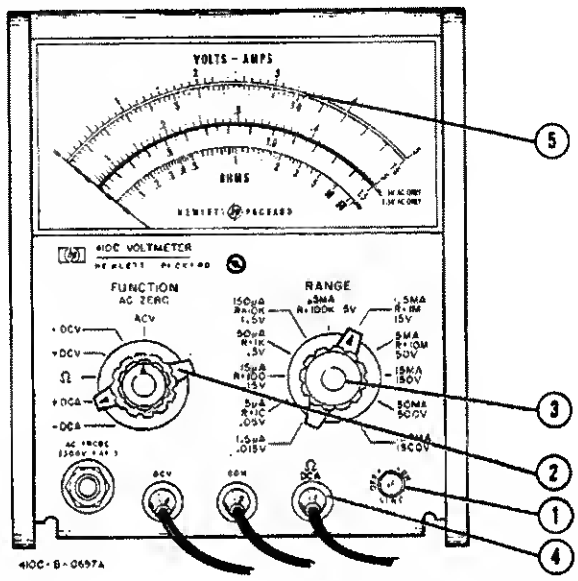
CAUTION

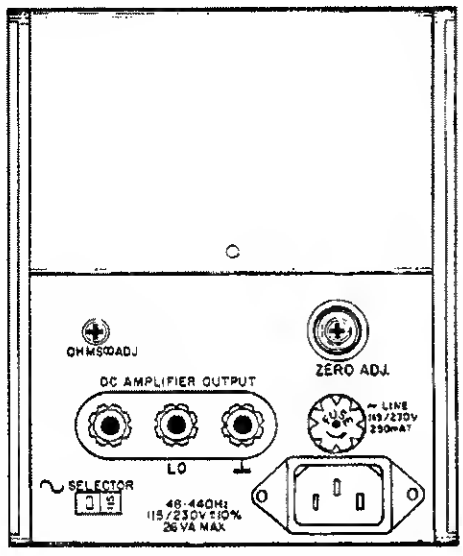
One side of almost all power distribution systems is grounded. Extreme caution must be used if direct measurement of power line voltages is attempted. If the ground clip lead is accidentally connected to the ungrounded side of the line, severe damage to the 410C is possible because of the short circuit created. Power line voltages can best be measured by using the probe tip only. Contacting the grounded power conductor will give a reading of 0 V while contacting the ungrounded lead will give full voltage reading.

3-18. Although the Model 410C indicates a full scale ac range of 500 V, the optional Model 11036A AC Probe should not be connected to ac voltages in excess of 300 V rms. AC voltage referenced to a dc voltage may be measured, but the AC Probe clip (alligator type) must be connected to the ground (⏚) of the circuit under test.

CAUTION

When measuring ac referenced to dc, the peak ac voltage plus dc voltage connected to the probe must not exceed 420 V.





(1) Depress the AC power switch (lamp-switch combination).

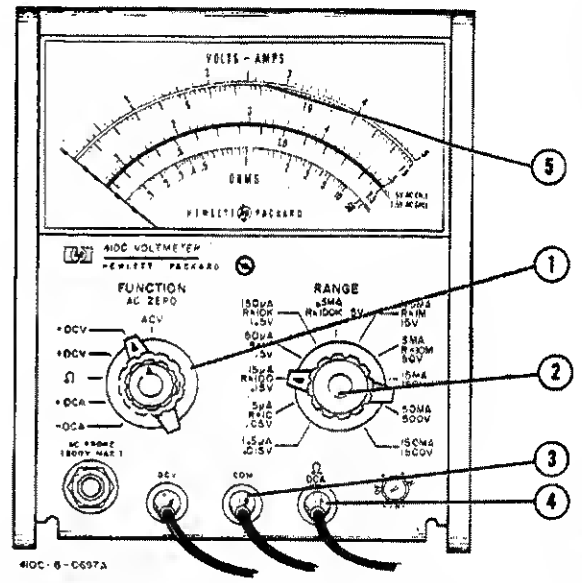
(2) Set FUNCTION SELECTOR to the polarity desired (+ DCA or - DCA).

(3) Set RANGE to desired current position.

(4) Connect the COM lead and the DCA/ohms probe in series with the circuit under test.

(5) Read the current on the VOLTS-AMPS scale.

Figure 3-3. DC Current Measurements.



(1) Set the FUNCTION SELECTOR to +DCV or −DCV (depending on direction of current flow).

(2) Set RANGE to desired range (0.015 V, 0.05 V, or 0.15V range).

NOTE

0.015 V range = 1.5 nano-amperes range
0.05 V range = 5.0 nano-amperes range
0.15 V range = 15 nano-amperes range

(3) Connect the OCV lead to the circuit under test.

(4) Connect the COM lead to the circuit under test.

(5) Read non-amperes from the meter on the VOLTS-AMPS scale (top two on meter) which corresponds to the range selected.

Figure 3-4. DC Nano-Ampere Current Measurements.

3-19. Precautions When Measuring AC Voltage.

3-20. Special considerations must be kept in mind when making ac voltage measurements. These considerations are discussed in the following paragraphs.

3-21. General Consideration of Complex Waveforms. Waveforms containing appreciable harmonics or spurious voltages will introduce error in the meter indication since the meter has been calibrated to read rms values of true sine waves while the Model 11036A Probe is a peak-above-average responding device. The magnitude of error that may be expected when harmonics are present on the measured waveform is indicated in Table 3-1.

Table 3-1. Possible Error when Measuring Voltage of Complex Waveforms.

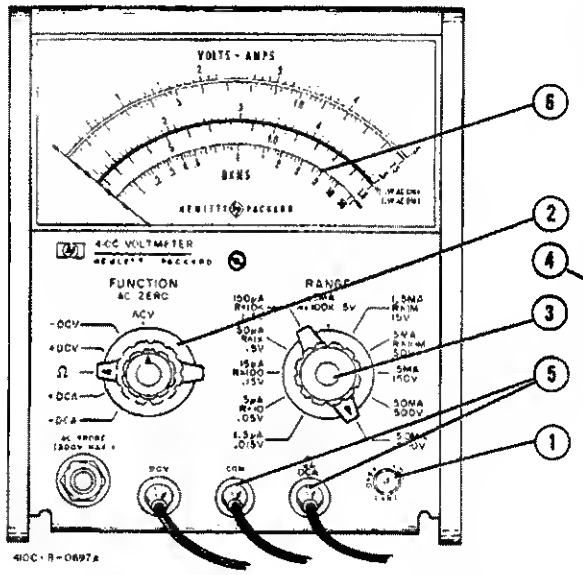
Harmonic	True RMS Value	Voltmeter Indicator
0	100	100
10% 2nd	100.5	90 to 110
20% 2nd	102	80 to 120
50% 2nd	112	75 to 150
10% 3rd	100.5	90 to 110
20% 3rd	102	87 to 120
50% 3rd	112	108 to 150

3-22. Voltage Measurements at Frequencies Below 50 Hertz. Voltage measurements at frequencies as low as 20 Hz may be made without loss of accuracy by removing the plastic probe head of the Model 11036A and using in its place a 0.25 μF blocking capacitor in series with the exposed contact of the probe.

CAUTION

The gray insulating material around the AC Probe is polystyrene, a low-melting point material. It is possible to solder to the contact which is exposed with the probe nose removed without destroying the polystyrene.

3-23. Voltage Measurement at High Frequencies. At frequencies above 100 MHz the distance between the point of voltage measurement and anode of the probe diode must be made as short as possible. If feasible, substitute a small disc type capacitor of approximately 50 pF for the removable tip on the probe. Solder one terminal of the button capacitor to the measurement point in the circuit and not to the probe contact. The probe contact (with tip removed) can then contact the other terminal of the capacitor for the measurement.



Before making resistance measurements, remove power from circuit to be tested. Be sure to discharge capacitors to eliminate any residual voltage.

(1) Depress AC power switch (lamp-switch combination).

(2) Set the FUNCTION SELECTOR to OHMS.

(3) Set RANGE to desired position.

(4) Adjust OHMS ∞ ADJ. control on rear panel to obtain an ∞ reading on the meter if necessary.

(5) Connect COM and DCA OHMS leads across the circuit component to be tested.

(6) Resistance is determined by multiplying the reading on the OHMS scale by the RANGE factor. EXAMPLE: If reading is 1.5 and factor is 10 K, then resistance equals 15kΩ.

Figure 3-5. Resistance Measurements.

3-24. At frequencies above 100 MHz considerable voltage may be built up across ground leads and along various parts of a grounding plane. Consequently, to avoid erroneous readings when measuring medium and high frequency circuits, use the ground clip lead on the shell of the probe to connect the circuit ground. In some cases at the higher frequencies it may be necessary to shorten the grounding lead on the probe.

3-25. For all measurements at higher frequencies, hold the molded nose of the probe as far from the external ground place or from object at ground potential as can conveniently be done. Under typical conditions, this practice will keep the input capacitance several tenths of a pF lower than otherwise.

3-26. For measurements above approximately 250 MHz it is almost mandatory that measurements be made on voltages which are confined to coaxial transmission line circuits. For applications of this type, the Model 11036A Probe is particularly suitable because the physical configuration of the diode and probe is that of a concentric line, and with a few precautions it can be connected to typical coaxial transmission line circuit with little difficulty.

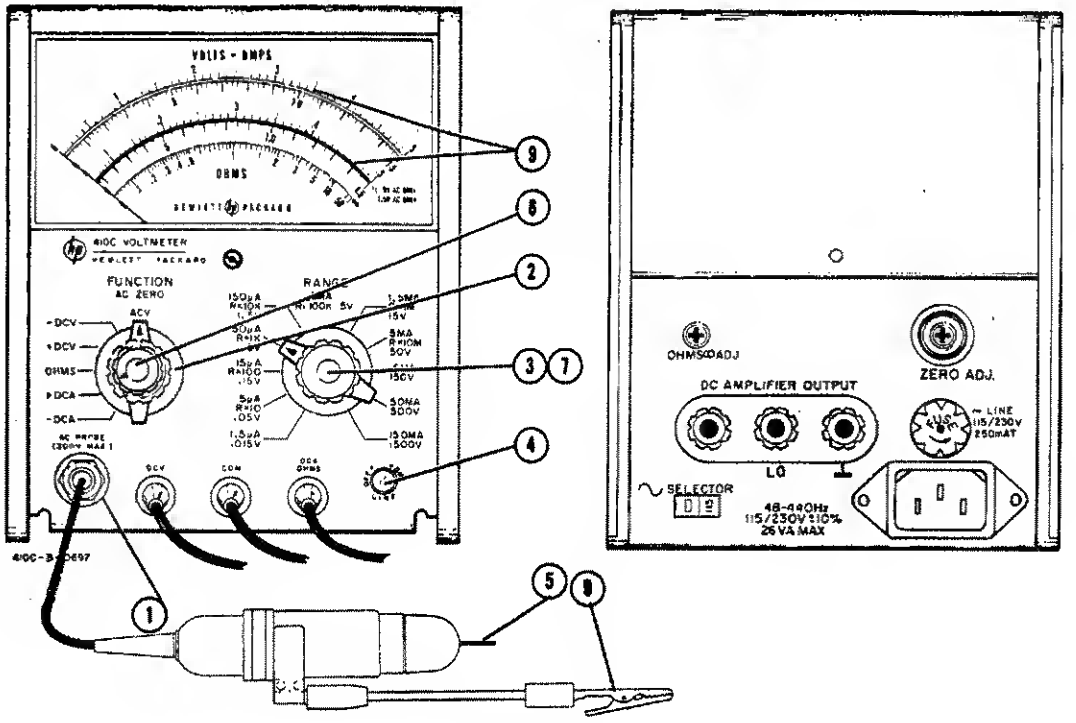
3-27. To connect the probe into an existing coaxial transmission line, cut the line away so the center conductor of the line is exposed through a hole large enough to clear the body of the probe. The nose of the probe should be removed for this type of measurement. Connect one terminal of a button-type capacitor of approximately 50 pF to the center conductor of the coaxial line so that the other terminal of the capacitor will contact the anode connection of the probe. A close-fitting metal shield or bushing should be arranged to ground the outer cylinder of the probe to the outer conductor of the transmission line. This type of connection is likely to cause some increase in the standing wave ratio of the line at higher frequencies. The Model 11042A Probe T Connector is designed to do this job with SWR of less than 1.1 at 500 MHz (see Paragraph 1-13).

3-28. Effect of Parasitics on Voltage Readings. At frequencies above 500 MHz leads or portions of circuits often resonate at frequencies two, three, or four times the fundamental of the voltage being measured. These harmonics may cause serious errors in the meter reading. Owing to the resonant rise in the probe circuit at frequencies above 1000 MHz, the meter may be more sensitive to the harmonics than to the fundamental. To make dependable measurements at these frequencies, the circuits being measured must be free of all parasitics.

3-29. Effect of DC Present with AC Signal. When measuring an ac signal at a point where there is a high dc potential, such as at the plate of a vacuum tube, the high dc potential may cause small leakage current through the blocking capacitor in the tip of the Model 11036A AC Probe. When the ac signal under measurement is small, the error introduced into the reading can be significant. To avoid leakage, an additional capacitor with a dielectric such as mylar or polystyrene which has high resistance to leakage is required. (Use 5 pF or higher, and insert the capacitor between the point of measurement and the probe tip).

3-30. Pulse Measurements.

3-31. Positive Pulses. The Model 11036A AC Probe is peak-above-average responding and clamps the positive peak value of the applied voltage. This permits the



CAUTION

Connect AC ground clip and COM Lead to earth ground only when in AC FUNCTION.

(1) Connect the -hp- Model 11036A AC Probe to the Model 410C at the AC PROBE receptacle.

(2) Set FUNCTION SELECTOR to ACV. NOTE: COM and chassis are internally connected when the FUNCTION SELECTOR is set to ACV.

(3) Set RANGE to 0.5 V.

(4) Depress the AC power button (lamp-switch combination) and allow 5 minute warmup.

(5) Short AC Probe Tip with Ground Clip.

(6) Adjust AC ZERO for a zero indication on the meter.

(7) Set RANGE to the desired voltage range.

(8) Connect AC Probe clip (alligator) to ground of circuit to be tested, and touch probe tip to test point. At lower frequencies COM Lead can be substituted for the AC Probe clip.

CAUTION

Before measuring voltages at frequencies above 100 MHz, refer to Figure 3-7 to determine the maximum amount of voltage that can be applied at that frequency.

(9) Read ac voltage on the VOLTS-AMPS scale. NOTE: When RANGE is on the 0.5 V and 1.5 V positions, use red meter scale.

Figure 3-6. AC Voltage Measurements.

probe to be used to measure the positive voltage amplitude of a pulse, provided the reading is multiplied by a factor determined from the following expression:

$$1.4\left(1+\frac{t_1}{t_2}+\frac{K}{PRF}\right)$$

t_1 is the duration of the positive portion of the voltage in microseconds.

t_2 is the duration of the negative portion of the voltage in microseconds.

K is a factor determined from the expression R_O/t_1 and the graph shown in Figure 3-8, where R_O is the source impedance of the pulse generator in kilohms, and t_1 is the duration of the positive portion of the pulse in microseconds.

PRF is the pulse repetition frequency in pulses per second (pps).

Suppose for example:

t_1 = 10 microseconds
t_2 = 990 microseconds
K = 0.45
PRF = 1000 pps

To find K, assuming R_O = 2 kΩ and t_1 = 10 microseconds: $R_O/t_1 = 2/10 = 0.2$. Locate 0.2 on the X axis of the graph shown as Figure 3-8, and read K where X and Y axes intersect the unmarked curve. If the ratio of R_O/t_1 were greater than 1, you would multiply the X and Y axes by 10, and use the curve marked "R_O/t_1 and K each X10."

Solving the expression for the multiplying factor.

$$1.4\left(1+\frac{10}{990}+\frac{0.45}{1000}\right)$$

$$1.4\ (1 + 0.01 + 0.00045) =$$

$$1.4\ (1.01045) = 1.41463$$

3-32. Negative Pulses.

3-33. In the case of a 10 microsecond negative pulse (t_2) and a pulse repetition frequency (PRF) of 1000 pps, t_1 would be 990 microseconds. Thus R_O/t_1 would be approximately 0, and from the graph it is seen that K is approximately 0. The expression would then reduce to

$$1.4\left(1+\frac{990}{10}\right)$$

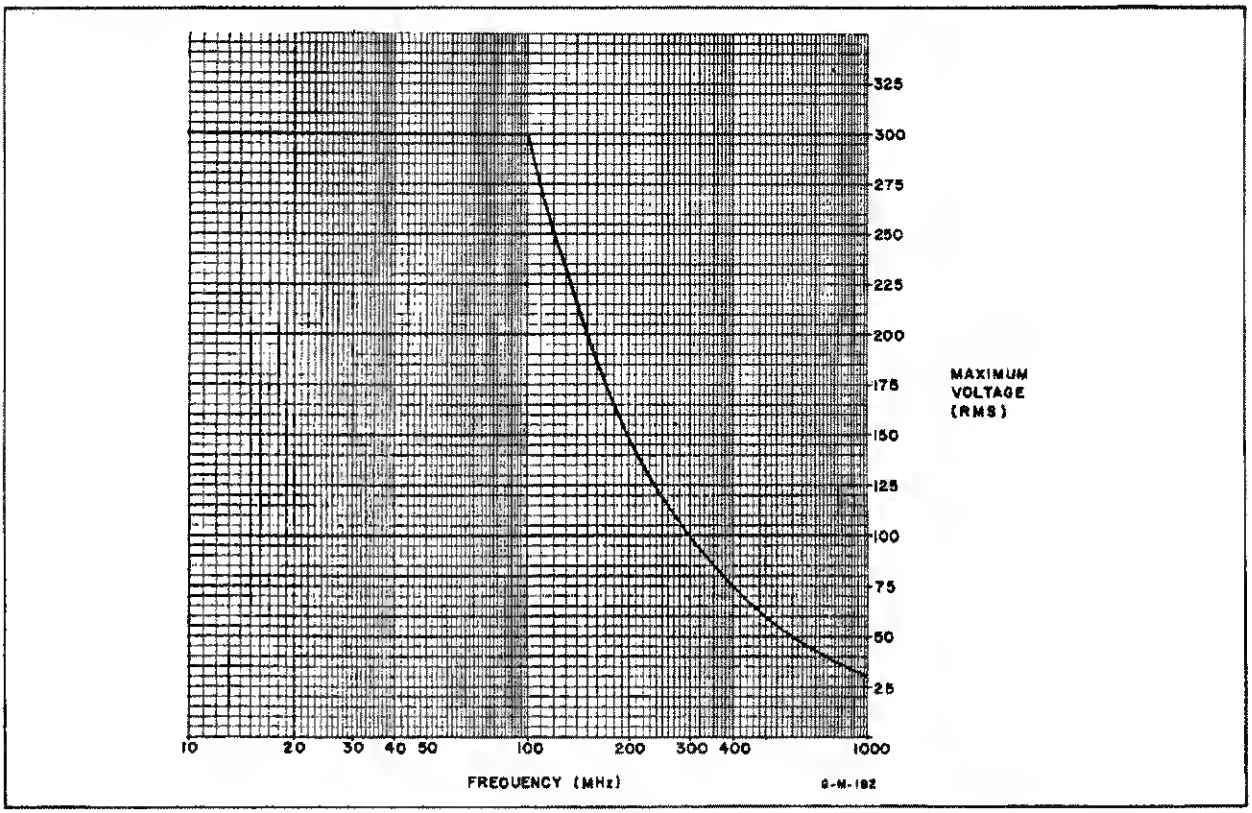


Figure 3-7. Maximum AC Voltage Chart For 11036A AC Probe.

3-34. It can be seen that in the case of negative pulses of short duration much smaller readings will be obtained for an equivalent positive pulse. As a result, large multiplying factors must be used and unless the pulse voltage is large, these measurements may be impractical.

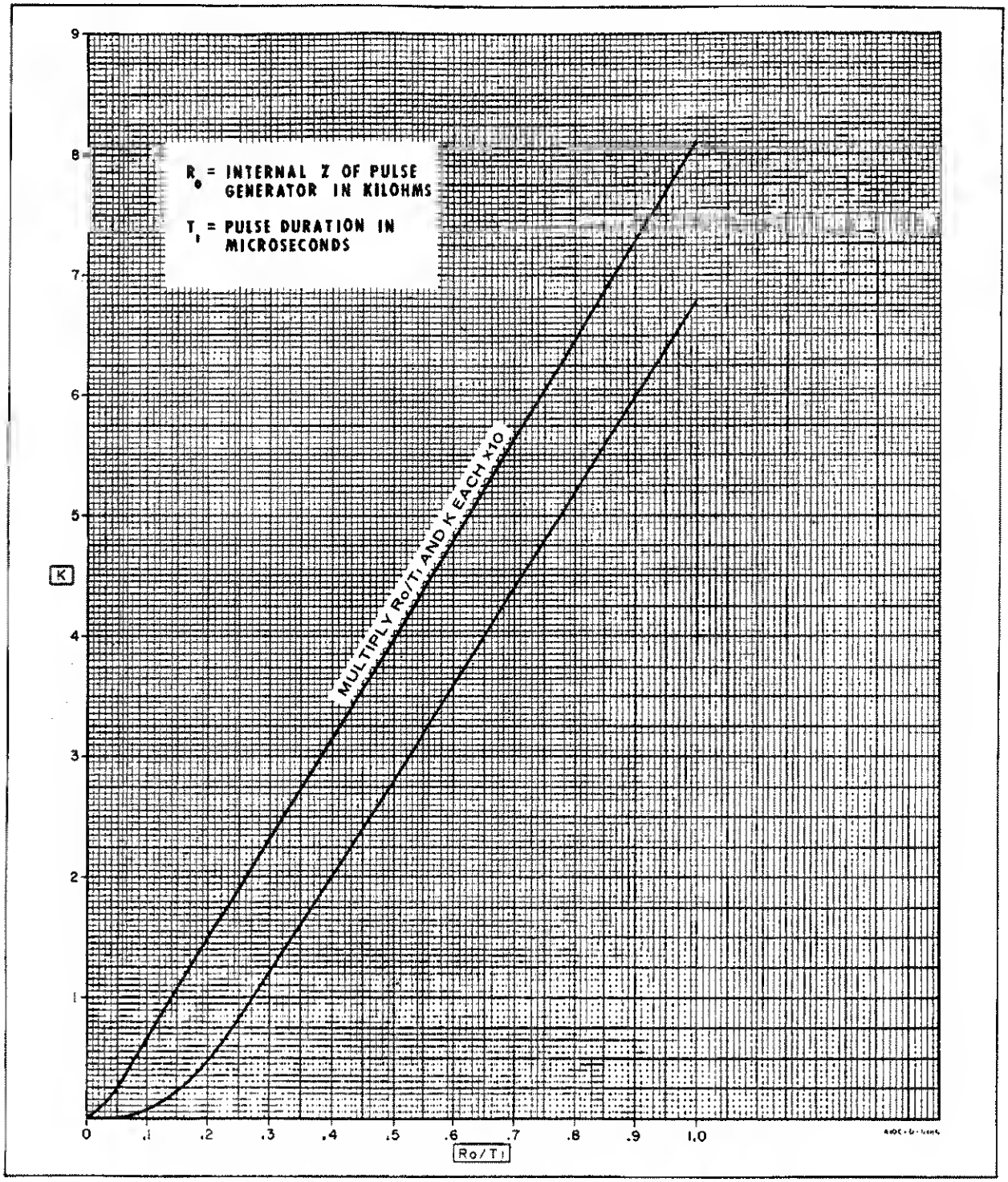


Figure 3-8. Graph Used In Calculations Of Pulse Voltage Readings.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL DESCRIPTION (FIGURE 4-1).

4-2. The -hp- Model 410C Analog Voltmeter is comprised of four basic blocks: (1) the Input Switching and Attenuator Network, (2) a FET Input Amplifier, (3) Meter and Feedback circuit, and (4) the Power Supply. Figure 4-1 is a basic block diagram of the Model 410C.

4-3. The signal inputs to the Input Switching and Attenuator Network are made through the appropriate input leads. AC voltages are rectified in the AC Probe, therefore all signals applied to the input network are dc. The input network attenuates the dc signal to a level determined by the RANGE and FUNCTION SELECTOR settings. The attenuated dc voltage is amplified to provide drive for the meter circuit. The output of the amplifier is a dc voltage proportional to the amplitude of the signal being measured. This output is also available on the instrument's back panel DC AMPLIFIER OUTPUT connector. A portion of the meter circuit voltage is returned to the amplifier as feedback. The gain of the amplifier is therefore determined by the feedback circuit.

4-4. CIRCUIT DESCRIPTION.

4-5. Input Switching and Attenuator.

4-6. The input network accurately attenuates the input voltage to a maximum of 15 mV at the amplifier input. Thls input network (resistors A3R30, A2R4, and A2R10 through A2R26) in conjunction with R1 (located in the DCV probe) presents an input impedance of 10 megohms on the three most sensitive ranges (DCV) and 100 megohms on the eight less sensitive ranges. (DCV and ACV).

4-7. Amplifier (Figure 5-8).

4-8. The amplifier in the Model 410C consists of a FET differential pair (Q1) and a low drift op amp (U1). The FET input circuit ensures that the input impedance of the amplifier is approximately 10^{12} ohms. The amplifier operates in the non-inverting mode with the feedback network (connected to inverting input) setting the gain of the amplifier (see Figure 4-1). The output of the amplifier drives meter M1 and is also applied to the DC AMPLIFIER OUTPUT connector (J2) located on the instrument's back panel.

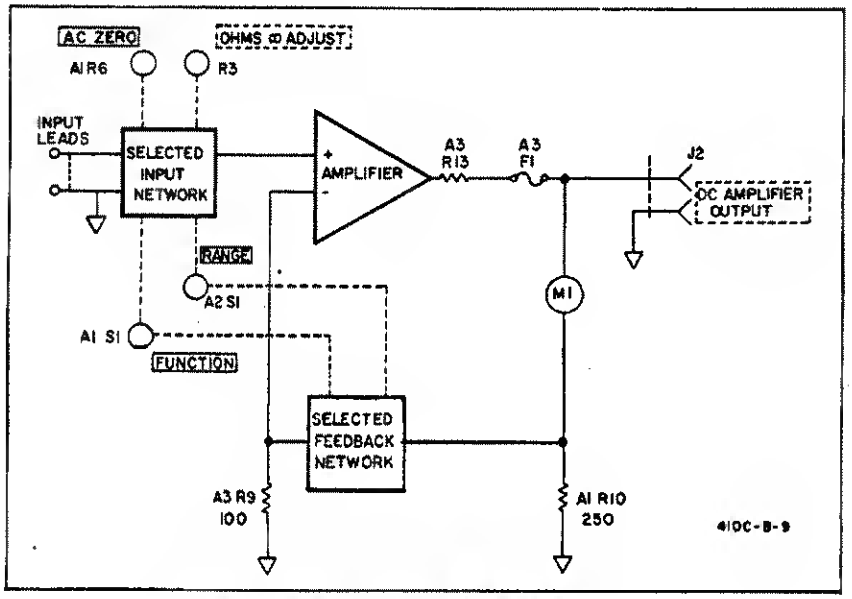


Figure 4-1. Block Diagram, Model 410C.

4-9. The input circuit protection diodes, CR1 and CR2, will conduct if too high a voltage is applied to the terminals for the selected range. Variable resistor A3R6 is the amplifier's DC Zero adjustment pot (see Paragraph 5-32). Variable resistor A3R12 is used during calibration to adjust the current to the input FET stage (see Paragraph 5-30).

4-10. The power supply voltages appearing at pins 8, 10, 13, and 15 are not used with the FET/op amp A3 Amplifier assembly (00410-66502). These voltages are required if the older Modulator/Demodulator A3 assembly is used (410C-65A). Resistor R18 is a dummy load for the +6 volts that was used for the vacuum tube filament on the 410C-65A board.

4-11. DC Current Measurements (Figure 5-13). The purpose of the input network is to provide proper attenation of currents applied. Currents from 1.5 μA to 150mA full scale are applied with input impedance decreasing from 9 kΩ on the 1.5 μA range to approximately 0.3 Ω on the 150 mA range.

4-12. The change in input impedance is varied by using dc current shunts in conjunction with RANGE switch A2S1. The dc voltage developed across these shunt resistors is amplified and applied to the meter, to provide a deflection on the meter proportional to the dc current being measured.

4-13. DC Voltage Measurements (Figure 5-14). The purpose of the input network is to accurately attenuate the input signal to a maximum of 15 mV at the amplifier input. The network presents an input impedance of 10 MΩ on the three most sensitive ranges and 100 MΩ on all other ranges.

4-14. Resistor R1 (located in the DCV probe) in conjunction with resistors A2R10 through A2R26, provides the 10 MΩ input impedance required for the three most sensitive DCV ranges. Resistors A2R4 and A3R30 are shunted out of the circuit by the RANGE switch on the three most sensitive DCV ranges.

4-15. When using the eight less sensitive ranges, A2R4 and A3R30 are placed in series with R1 and A2R10 through A2R26 to present more than 100 MΩ impedance to the input.

4-16. A3R30 is used to calibrate full scale on the 1500 V range (see Paragraph 5-33).

4-17. Resistance Measurements (Figure 5-15). The purpose of the input network is to place an approximately 0.6V dc source in series with a known (reference) resistance. The resistance to be measured is placed in parallel with the known resistance, which changes the voltage proportionally. The maximum changes in voltage applied to the modulator is 15 mV because of attenuation provided by A2R4, A3R30, and A1R2.

4-18. A dc current of approximately 60 mA is supplied at the junction of A2R22 and A2R23 through A7R10, R3, A2R2 and A2R1 to the input network. The OHMS ∞ ADJ., R3, sets the meter for full scale (∞). Resistor A2R1 is shorted out in the X1M position of the RANGE switch; resistors A2R1 and A2R2 are shorted out in the X10M range. The resistors A2R2 and/or A2R1 are electrically removed from the circuit to increase the voltage at the junction of A2R22 and A2R23. This is done to compensate for the loading of the attenuator (A2R4, A3R30, and A1R2) on these ranges.

4-19. AC Voltage Measurements (Figure 5-16). AC voltages are rectified in the AC Probe and applied to the input network. The input signal is attenuated to produce a maximum of about 15 mV at the amplifier input. AC zero adjustment of meter pointer is made with the AC ZERO control.

4-20. Tha Feedback Network.

4-21. The feedback network drives the meter and determines the dc gain of the amplifier. The feedback is varied depending on the position of the FUNCTION and RANGE selectors. The different feedback configurations are discussed in paragraphs 4-22 and 4-23.

4-22. Feedback Network for ±DCA, Ohms, and ±DCV. Figures 5-13, 5-14 and 5-15 show the feedback configuration for all positions of tbe FUNCTION SELECTOR except ACV. The meter is electrically inverted for ±DCV and ±DCA modes of operation. The DC OUTPUT ADJ., A6R20 sets tbe output voltage. The dc pot, A6R18 determines the amount of feedback to the amplifier. The resistor A2R30 is in the circuit in the ± .015 DCV and ± 1.5 μA modes of operation to decrease feedback. This increases the amplifier's gain to compensate for the decrease in input signal to the amplifier on these ranges.

4-23. Feedback Circuit for AC Voltage Measurements. Figure 5-16 shows the feedback configuration for the ACV position of the FUNCTION SELECTOR switch, A1S1. The resistors that are placed in the circuit by the RANGE switch, program the amplifier gain to compensate for the non-linear response of the AC Probe. A6R16 and A6CR1 compensate the non-linear response of the AC Probe to the linear calibration of the upper meter scale on the 5 V range.

4-24. Powar Supply.

4-25. Primary Power (Figure 5-7). Either 115 or 230 V ac power is connected through fuse F1 (0.25 amp slow-blow) and switch S1 to the primary of power transformer T1. Switch S2 connects T1 primaries in parallel for 115V operation or in series for 230 V operation.

4-26. Unregulated and Zener Regulated Power Supply with 410-65A A3 Assembly. The full-wave rectifier circuit consisting of CR1 and CR2 produces unregulated +270 V which is used to drive the photochopper neons. Unregulated +175 V and +140 V are tapped off and used to provide B+ for the plates of A3V1B and A3V1A, respectively. Zener regulators A7CR6 and CR7 provide regulated +38 V and −9 V to bias A3Q1 and A3Q2. Filtering of the outputs is provided by the RC network consisting of A7R1 through A7R3 and C5A through C5D.

4-27. Unregulated and Zener Regulated Power Supply with 00410-66502 A3 Assembly. Plus 38 V and −9 V are the only voltages used by the FET/op amp A3 Amplifier Assembly. A 20 V zener and a 4.75 V zener on the A3 board are used to provide regulated voltages for Q1 and U1.

4-28. Series Regulated Power Supply. The output of the full wave rectifier CR3 and CR4 is regulated by transistor Q1, which is connected in series with the output. Zener diode A7CR8 provides reference voltage to the base of Q1. Regulated + 6 V is supplied to the filaments of A3V1A/B and the AC Probe diode A8V1. Plus 0.6 V is provided through A7R10 to R3, the OHMS Ω ADJ. control. Filtering of the outputs is provided by C6A and C6B.

4-29. Standby Filament Supply. The filament tap (T1, pins 1 and 2) provides 6.0 V ac to the filament of the AC Probe diode, A8V1, so that the filament remains warm when the Model 410C is being used in modes of operation other than ACV. When FUNCTION selector A1S1 is switched to ACV, 6.0 V ac is removed from the filament and 6 V dc is applied. Therefore, the ACV mode is ready for immediate use, without waiting for the filament to warm up.

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be parformed only by sarvice-trained personnel who ara aware of the hazards involved (for example, fire and elactrical shock). Where maintenance can be performed without power applied, the power should be removed.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains performance test procedures, adjustment and calibration procedures, troubleshooting procedures, circuit schematics and simplified schematics of each measurement function to aid in the troubleshooting process of the Model 410C Electronic Voltmeter.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to maintain and adjust the Model 410C is listed in Table 5-1. Equipment having similar characteristics may be substituted for items listed.

5-5. PERFORMANCE TESTS.

5-6. The performance tests presented in this section are front panel operations designed to compare the Model 410C with its published specifications. These operations may be incorporated in periodic maintenance, post repair and incoming quality control checks. These operations should be conducted before any attempt is made at instrument calibration or adjustment. During performance tests, periodically vary the line voltage to the Model 410C, ± 10% on either 115 V or 230 V operation. A 1/2 hour warm-up period should be allowed before these tests are conducted.

Table 5-1. Recommended Test Equipment.

Instrument Type	Required Characteristics	Use	Recommended Model
DC Voltage Standard	Range: 0.015 to 300 V Accuracy: ± 0.2% dc	DC Accuracy Checks and Calibration Adjustments	Systron - Donner Model M107
AC Calibrator with High Voltage Amplifier	Frequency: 20 Hz to 100 kHz Output: .5 V to 300 V	AC Voltmeter Accuracy Test	-hp- Model 745 and 746 AC Calibrator and High Voltage Amplifier
Oscillator	Frequency: 20 Hz to 10 MHz Output: 2.0 V	Frequency Response Test	-hp- Model 652A Test Oscillator
DC Power Supply	Range: 0 to 10 V Continuous	DC Ammeter Accuracy Tests	-hp- Model 6214A DC Power Supply
Digital Multimeter	Range: 20mV-200V,DC;10V RMS,AC Accuracy: ± 0.2%	Accuracy Tests: Power Supply Measurements: Troubleshooting	-hp- Model 3466A Digital Voltmeter
VHF Signal Generator	Frequency: 10 MHz to 400 MHz Output: 1.0 V	Frequency Response Test	-hp- Model 606E VHF Signal Generator
UHF Signal Generator	Frequency: 460 MHz to 700 MHz	Frequency Response Test	-hp- Model 612A UHF Signal Generator
Micro-Potentiometer	Frequency Range: 10 MHz 700 MHz Output Voltage: 0.44 V rms Accuracy: NBS Calibrated	Frequency Response Test Micro-Potentiometer	Ballantine Model 440
Probe-T-Connector	For use with 50 ohm transmission line	Frequency Response Test	-hp- Model 11042A Probe-T-Connector
Connector Adapter	Type N Male to BNC Female	Frequency Response Test	-hp- Part Number 1250-0067
Connector Adapter	BNC to Binding Post	Frequency Response Test	-hp- Part Number 10110A
Connector Adapter	Type "N" Male to Type "N" Female	Frequency Response Test	-hp- Part Number 11501A
50 Ω Termination	Frequency Range: 10 MHz to 700 MHz Low Reflection	Frequency Response Test	-hp- Part Number 908A
50 Ω Feed-Thru	Male BNC to Female BNC	Performance Tests	-hp- Model 11048C
Resistors: 10 MΩ 56 K 10 K 1.5 K 56 Ω 10 Ω	 Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1% Accuracy: ± 1%	 Performance Tests Performance Tests Performance Tests Performance Tests Performance Tests Performance Tests	 -hp- Part Number 0730-0166 -hp- Part Number 0730-0053 -hp- Part Number 0727-0157 -hp- Part Number 0730-0017 -hp- Part Number 0811-0341 -hp- Part Number 0727-0335

5-7. Machanical Matar Zero.

a. Instrument must be turned off for a few minutes or install a short across the meter terminals.

b. Rotate mechanical zero-adjustment screw on front panel clockwise until pointer reaches zero, moving up scale.

c. If for some reason the pointer should overshoot zero, repeat step b until desired results are obtained.

d. When pointer has been positioned at zero, rotate zero-adjust screw slightly counterclockwise to free it. If meter pointer moves to the left during this action, repeat steps b and d.

WARNING

Hazardous voltages used in some of the following tests.

5-8. DC Voltmatar Dperation.

5-9. Accuracy Test (DCV).

a. Short Model 410C DCV probe to COM lead; set pointer to zero using rear panel adjustment (ZERO ADJ).

b. Set the Model 410C FUNCTION SELECTOR to the + DCV position; RANGE switch to .015 V. Connect Model 410C DCV and COM cables to the DC Standard output Terminals.

c. Adjust DC Standard and Model 410C to settings listed in Table 5-2.

Table 5-2. DCV Accuracy Test.

Model 410C Range Settings	DC Standard Settings Voltage	Model 410C Meter Readings
.015 V	± .015	.0147 to.0153 V
.05 V	± .05	.049 to .051 V
.15 V	± .15	.147 to .153 V
.5 V	± .5	.49 to .51 V
1.5 V	± 1.5	1.47 to 1.53 V
5 V	± 5	4.9 to 5.1 V
15 V	± 15	14.7 to 15.3 V
50 V	± 50	49 to 51 V
150 V	± 150	147 to 153 V
500 V	± 300	290 to 310 V
1500 V	± 300	270 to 330 V

d. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-26 for adjustment procedure.

5-10. Inpot Resistance Test (DCV).

a. Connect a digital voltmeter (-hp- 3466A) to the DC Amplifier Output. Set digital voltmeter range to 10 V.

b. Set 410C RANGE to .015 V, FUNCTION to + DCV.

c. Connect the DC Standard in series with a 10 MΩ ± 1% resistor (-hp- Part Number 0730-0168). Set the DC Standard output to + .015 V. Connect the Standard and series resistor to the 410C DCV probe.

d. Adjust the calibrator and 410C to settings listed in Table 5-3. Digital voltmeter readings should be within the limits specified for each setting. If readings are not within limits, refer to Paragraph 5-35, Amplifier Output Calibration; recalibrate amplifier and repeat test.

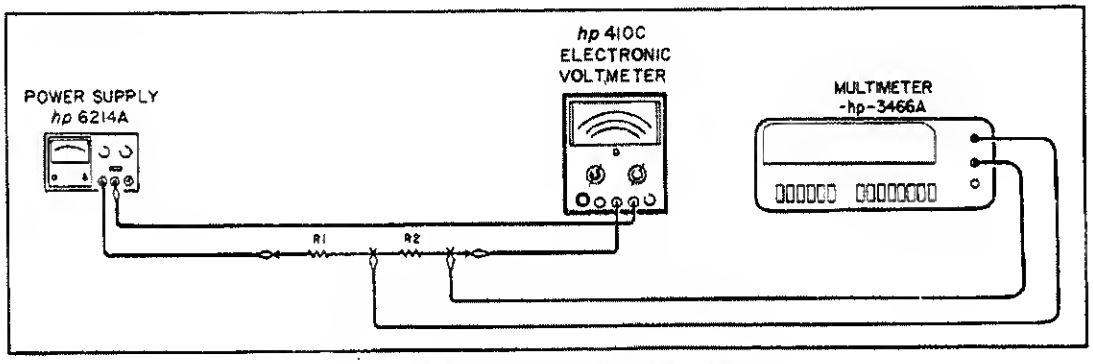


Figura 5-1. DC Ammater Dperation.

Table 5-3. DCV Input Resistance Test.

Model 410C Range Settings	DC Standard Voltage	Model 3466A Voltage Readings	Model 410C R_{in}
.015 V	.015	0.7202 to 0.7801	10 MΩ ± 3%
.05 V	.05	0.7202 to 0.7801	10 MΩ ± 3%
.15 V	.15	0.7202 to 0.7801	10 MΩ ± 3%
.50 V	.50	1.333 to 1.394	100 MΩ ± 1%
1.5 V	1.5	1.333 to 1.394	100 MΩ ± 1%
5 V	5	1.333 to 1.394	100 MΩ ± 1%
15 V	15	1.333 to 1.394	100 MΩ ± 1%
50 V	50	1.333 to 1.394	100 MΩ ± 1%
150 V	150	1.333 to 1.394	100 MΩ ± 1%
500 V	300	0.600 to 0.863	100 MΩ ± 1%
1500 V	300	0.255 to 0.280	100 MΩ ± 1%

5-11. DC Ammeter Operation.

5-12. Accuracy Test (DCA).

a. Figure 5-1 describes the test arrangement required for this operation.

b. Connect the Model 410C as shown in Figure 5-1; FUNCTION SELECTOR to + DCA; RANGE to 150 mA.

c. Use 56 Ω resistor for R1 and 10 Ω resistor for R2.

d. Adjust dc power supply to obtain reading on dc voltmeter specified in Table 5-4; change R_1 and R_2 according to Table 5-4.

e. Model 410C should read within limits specified in Table 5-4. If not, refer to Paragraph 5-26 for adjustment procedure.

5-13. Ohmmeter Operation.

5-14. Ohmmeter Accuracy Test.

a. A 10 Ω ± 1% resistor (-hp- Part Number 0727-0335) and a 10 M ± 1% resistor (-hp- Part Number 0730-0168) will be required for this test.

b. Set Model 410C FUNCTION SELECTOR to OHMS; RANGE to RX10.

c. Set pointer to ∞ using rear panel adjustment (OHMS ADJ) if required.

d. Connect COM and DCA OHMS cables across 10 Ω resistor.

e. Meter should read 10 Ω (± 5%).

f. Set Model 410C RANGE to RX10M. Replace 10 Ω resistor with 10 MΩ resistor.

g. Meter should read 10 MΩ (± 5%).

h. If both of these ranges function properly, it can be assumed that the remainder will also. If meter does not function properly, refer to Paragraph 5-26 for adjustment procedure.

5-15. Amplifier Operation.

5-16. Amplifier Gain Test.

a. Connect the DC standard output to Model 410C DCV and COM cables.

Table 5-4. DCA Accuracy Test.

Model 410C Range Settings	DC Voltmeter Readings	Model 410C Meter Readings	R_1 Ω	R_2 Ω
150 MA	1.4 V	135.5 to 144.5 MA	55	10
50 MA	.4 V	36.5 to 41.5 MA	56	10
15 MA	.14 V	13.55 to 14.55 MA	58	10
5 MA	.04 V	3.85 to 4.15 MA	56	10
1.5 MA	.014 V	1.35 to 1.45 MA	58	10
.5 MA	.004 V	0.385 to 0.415 MA	56	10
150 μA	1.38 V	133.5 to 142.5 μA	58 K	10 K
50 μA	0.46 V	44.5 to 47.5 μA	58 K	10 K
15 μA	0.138 V	13.35 to 14.25 μA	56 K	10 K
5 μA	0.048 V	4.45 to 4.75 μA	58 K	10 K
1.5 μA	0.014 V	1.38 to 1.45 μA	58 K	10 K

b. Connect DC Voltmeter (-hp- Model 3466A) to DC AMPLIFIER OUTPUT on rear panel of Model 410C. Set DC Voltmeter RANGE to 10 V.

c. Set Model 410C FUNCTION SELECTOR to + DCV; RANGE to .015 V.

d. Adjust the DC Standard for + .015 VDC output.

e. The dc voltmeter should indicate from 1.467 V to 1.533 V. This will verify a gain of 100, where the gain equals E_{DC} out/E_{DC}in.

f. If the dc voltmeter does not indicate within the limits of step e, refer to Paragraph 5-26 for proper adjustment procedure.

5-17. Output Level Test.

a. A DC Standard and a DC Voltmeter (-hp- Model 3466A) will be required for this test.

b. Connect dc voltmeter to dc amplifier OUTPUT on Model 410C rear panel. Place ground lead between Model 410C circuit ground and earth ground terminals. Set dc voltmeter RANGE to 10 V.

c. Set Model 410C FUNCTION SELECTOR to + DCV; RANGE to 1.5 V.

d. Adjust the DC Standard to provide + 1.5 V.

e. Model 410C and dc voltmeter should indicate from 1.467 V to 1.533 V.

f. If dc voltmeter does not indicate within the limits of step e, refer to Paragraph 5-26 for proper adjustment procedure.

5-18. Amplifier Output Impedance Test.

a. Connect an external DC Voltmeter (-hp- Model 3466A) to Model 410C DC AMPLIFIER OUTPUT terminals on rear panel.

b. Set Model 410C FUNCTION SELECTOR to OHMS position; RANGE to RX10K.

c. Record voltage indicated on external dc voltmeter for use as a reference.

d. Connect a 1.5 kΩ ± 1% resistor (-hp- Part Number 0730-0017) across 410C DC AMPLIFIER OUTPUT terminals. DC voltage recorded in step c above should not change more than 3 mV, indicating that dc amplifier output impedance is within the 3 Ω specification at dc.

5-19. Amplifier Noise Test.

a. Connect an AC Voltmeter (-hp- Model 3466A) to the DC AMPLIFIER OUTPUT of Model 410C.

b. Set the Model 410C FUNCTION SELECTOR to + DCV; RANGE to 1500 V.

c. Short the Model 410C DCV and COM cables. External ac voltmeter reading should be less than 2.65 mV rms (7.5 mVp-p).

d. Reset Model 410C RANGE to 1.5 V. AC Voltmeter should read less than 2.65 mV rms.

5-20. Overload Recovery Test.

a. Connect the DC Standard output to Model 410C DCV and COM cables.

b. Set Model 410C FUNCTION SELECTOR to + DCV; RANGE to .15 V.

c. Adjust the DC Standard for +0.15 VDC; note reading on Model 410C.

d. Readjust the DC Standard for + 15 VDC output; wait 5 seconds for complete saturation; then switch voltmeter calibrator back to + .15 VDC output. Note time required for meter to return to original position.

e. Recovery time should be less than 3 seconds.

f. Repeat this same Overload Recovery Test with the 410C set for − DCV and the DC Standard set for − DCV.

5-21. AC Rejection Test.

a. An AC Calibrator (-hp- Model 745A) and an RMS Voltmeter (-hp- Model 3466A) are required for this test.

b. Set 410C FUNCTION SELECTOR to -DCV; RANGE to .015 V.

c. Connect the AC Calibrator output to Model 410C DCV and COM cables and input of rms voltmeter. Set rms voltmeter to read 10 V.

d. Adjust the AC Calibrator to provide 3.18 V (4.5 V peak) reading on rms voltmeter at 50 Hz.

e. Model 410C should not read more than 2.25 mV verifying 66 dB ac rejection at 50 Hz.

f. Increase frequency to check ac rejection about 60 Hz.

g. Switch Model 410C FUNCTION SWITCH to + DCV and repeat steps e and f.

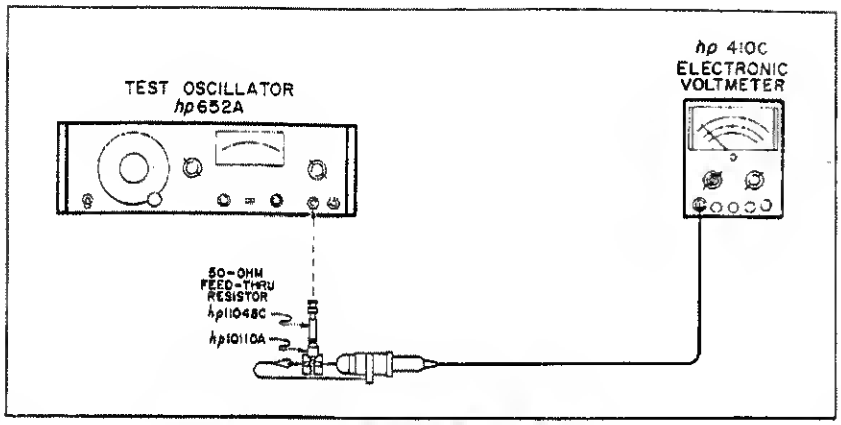


Figure 5-2. Low Frequency Response Test.

5-22. AC Voltmeter Operation.

CAUTION

When measuring ac voltages, do not permit ac ground jumper of Model 410C AC Probe to contact ungrounded side of ac source or serious damage to 410C will result.

WARNING

Hazardous voltages used in some of the following tests.

5-23. AC Voltmeter Accuracy Test.

a. Set Model 410C RANGE to 0.5 V. Short the input of tbe AC Probe. Adjust ZERO vernier for zero pointer deflection.

b. Connect ACV probe to the AC Calibrator (-hp- Model 745A).

c. Adjust the AC Calibrator for 400 Hz output.

d. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 500 V.

e. Adjust the AC Calibrator to settings listed in Table 5-5. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-36 for corrective action. Record Model 410C reading with 0.3 V input.

NOTE

The frequency response tests are performed using reference voltage obtained with 0.3 V input.

Table 5-5. AC Accuracy Test.

410C Range	Voltmeter Calibrator 400 Hz Voltage Selection	Model 410C Readings
500 V	300	285 to 315 V
150 V	150	145.5 to 154.5 V
50 V	50	48.5 to 51.5 V
15 V	15	14.55 to 15.45 V
5 V	5	4.85 to 5.15 V
1.5 V	1.5	1.455 to 1.545 V
.5 V	0.5	0.485 to .515 V
.5 V	0.3	0.285 to .315 V

5-24. AC Voltmeter Low Frequency Response Test.

a. A Test Oscillator (-hp- Model 652A), a BNC-to-Binding Post Adaptor (-hp- Part Number 10110A) and a 50 Ω Feed-thru Termination (-hp- Part Number 11048C) are required for this test.

b. Connect Model 410C as shown in Figure 5-2.

c. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 0.5 V.

d. Set Test Oscillator frequency to 400 Hz, and adjust amplitude to give same 410C reading as recorded in Paragraph 5-23, step e, with 0.3 V input.

e. Set Test Oscillator REF SET to convenient level.

f. Adjust frequency of Test Oscillator to various cardinal points between 20 Hz and 10 MHz, resetting amplitude to reference level set in step d for each frequency. Model 410C readings should be the same as the reading set at 400 Hz in step d ± 10% from 20 Hz to 100 Hz and ± 2% from 100 Hz to 10 MHz.

5-25. AC Voltmeter High Frequency Response Test.

a. A VHF Signal Generator (-hp- Model 608E), a UHF Signal Generator (-hp- Model 612A), a Probe-T-Connector (-hp- Model 11042A), a Micropotentiometer (Ballantine Model 440), and a DC Voltmeter (-hp- Model 3466A) are required for this test. Figure 5-3 describes test arrangement to be used.

NOTE

The micropotentiometer must have the proper radial resistance and current rating to deliver 0.30 V at its output.

b. Set VHF oscillator output to provide output to Model 410C reading recorded in Paragraph 5-24, step f, with .3 V input; frequency to 10 MHz. Record dc voltmeter reading for reference.

c. Vary VHF oscillator frequency from 10 MHz to 480 MHz maintaining reference dc voltmeter reading by readjusting VHF oscillator output. Model 410C reading should be the same as the reading set at 400 Hz in Paragraph 5-24, step d, ± 2% at frequencies to 50 MHz, 0 to -4% from 50 MHz to 100 MHz and ± 1.5 dB at all higher specified frequencies.

d. Replace VHF oscillator with UHF oscillator in Figure 5-3. Repeat steps b and c for UHF oscillator output frequencies from 480 MHz to 700 MHz.

WARNING

Calibration described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock).

Socket for A3 board has dangerous voltages (+270 V, +175 V, and +140 V). See Schematic 5-8.

5-26. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-27. The following is a complete calibration procedure for the Model 410C. These operations should only be performed if it has been determined by the Performance Tests, Paragraph 5-5, that the Model 410C is out of adjustment. If the procedures outlined do not resolve any discrepancies that may exist, refer to Paragraph 5-40, Troubleshooting, for a possible cause and recommended corrective action.

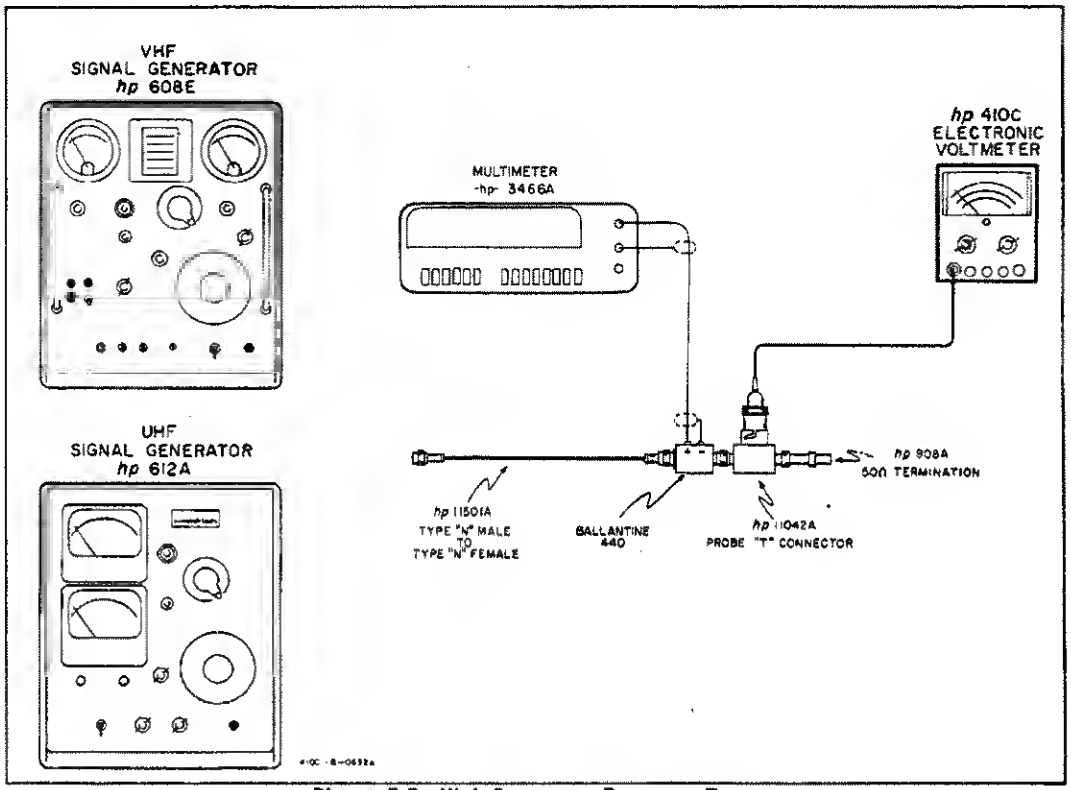


Figure 5-3. High Frequency Response Test.

5-28. Disconnect the ac power from the Model 410C. Remove the top and bottom covers and the two side panels from the instrument. Refer to Figure 5-4 and 5-5 throughout this procedure for adjustment locations.

5-29. Powar Supply Test.

a. Apply power to 410C.

b. Refer to Table 5-6 and Figure 5-7 for Power Supply test points and typical voltage values. Measure dc voltages between COM lead and designated location on A7.

Tabal 5-5. Power Supply Test.

Voltage	Location on A7 (Figure 5-8)	Tolerance
+ 3a V	Junction of CR6 and R4	± 8..0 V
+ 6 V	926	± 0.6V
− 9 V	Junction CR7 and R7	± 1.8 V

5-30. Amplifiar Currant Adjustment.

a. Connect a 3466A voltmeter or equivalent voltmeter with an input impedance of 10 M ohms or greater across A3R7.

b. Adjust A3R12 for the voltmeter to read 9.476 V dc; 400 μA will be flowing through R7 with this 9.476 V reading.

5-31. DC VOLTMETER CALIBRATION.

5-32. DC Zaro Adjustment.

a. Set Model 410C FUNCTION SELECTOR to +DCV and RANGE switch to 0.5 V.

b. Short the DCV probe to the COM lead.

c. Set the DC ZERO adj. control at the back of the instrument its center position.

d. Adjust the Zero Adj. pot A3R6 on the A3 amplifier board till there is no meter movement when the FUNCTION SELECTOR is switched from −DCV to +DCV.

5-33. DC Full Scale Adjost.

a. Connect the Model 410C DCV and COM cables to the DC Standard output terminals.

b. Set the Model 410C FUNCTION switch to the +DCV position and the RANGE switch to the .015 V position.

c. Set the DC Standard for an output voltage of .015 VDC.

d. Adjust A6R18 to provide a full scale reading.

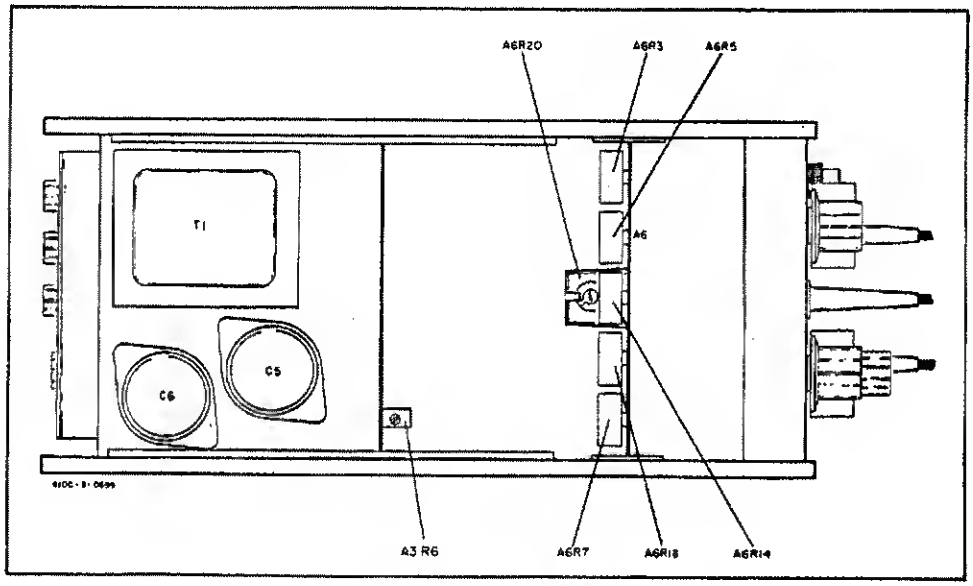


Figure 5-4. Adjustmant Locations.

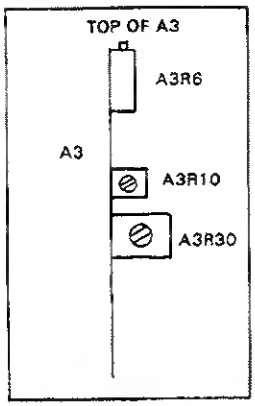


Figure 5-5. A3 Board Adjustment Locations.

e. Using Table 5-7 as a guide, adjust A6R18 to a setting which will provide the best overall full scale readings on the 0.015 V, 0.05 V, 0.15 V ranges. Adjust A3R30 for the best overall full scale readings on all ranges above 0.15 V.

NOTE

A6R18 must be adjusted before A3R30 because A6R18 affects all ranges, and A3R30 only affects ranges above the 0.15 V range.

Table 5-7. DCV Calibration Procedure.

Model 410C Range Settings	DC Standard Voltage	Model 410C Meter Readings	Adjustment
.015 V	.015	.0147 to .0153 V	A6R18
.05 V	.05	.049 to .051 V	A6R18
.15 V	.15	.147 to .153 V	A6R18
.5 V	.5	.49 to .51 V	A3R30
1.5 V	1.5	1.47 to 1.53 V	A3R30
5 V	5	4.9 to 5.1 V	A3R30
15 V	15	14.7 to 15.3 V	A3R30
50 V	50	49 to 51 V	A3R30
150 V	150	147 to 153 V	A3R30
500 V	300	290 to 310 V	A3R30
1500 V	300	270to 330 V	A3R30

5-34. Ohmmeter Calibration.

a. Set the Model 410C FUNCTION SELECTOR switch to OHMS and the RANGE to RX10M.

b. Short the OHMS and COM leads together. The Model 410C should read zero. If it does not, recheck the DC ZERO ADJ (see 4-32). Check for a zero reading on all ranges. The RX10 range should read about 0.1 ohms which is the resistance of the leads.

c. Disconnect the OHMS and COM leads. Adjust the OHMS ADJ (410C rear panel) for a reading of infinity.

d. The meter should indicate infinity when the range switch is changed to other ranges.

5-35. Amplifier Output Calibration.

a. Set the Model 410C FUNCTION SELECTOR switch to the + DCV position and the RANGE switch to 5.0 V.

b. Connect the 410C DCV and COM leads to the DC Standard. Set the DC Standard for a voltage output of 5.0 V.

c. Connect the 3466A voltmeter to the DC AMPLIFIER OUTPUT terminals on the back of 410C.

d. Adjust A6R20 to give a 1.5 V dc reading on the voltmeter.

NOTE

The amplifier output will give a negative voltage for all negative dc and ac inputs.

5-36. AC VOLTMETER CALIBRATION.

5-37. An AC Calibrator (-hp- Model 745 and 746 or equivalent) is required for the AC Voltmeter calibration.

5-38. AC Zero Adjust.

a. Insert the telephone plug from the 11036A AC Probe into the AC Probe receptical on the Model 410C. Set the FUNCTION SELECTOR switch to the ACV position and the RANGE switch to 0.5 V. Allow 5 minutes for the diode in the AC Probe to stabilize.

b. Set the AC Zero vernier, which is concentric with the FUNCTION SELECTOR switch, to the center of its roatation.

c. Short the Model 11036A AC Probe tip to the AC Probe common.

d. Adjust A3R31 for a Model 410C meter reading of zero.

e. If necessary, use the AC ZERO vernier as a fine adjust to obtain the Model 410C meter indication of zero.

5-39. AC Full Scale Adjust.

CAUTION

When measuring ac voltages, do not allow the ac ground lead of the 11036A AC Probe to contact the ungrounded side of the ac source or serious damage to the Model 410C will result.

a. Connect the Model 410C AC PROBE (11036A) to the output terminals of the AC CALIBRATOR.

b. Set the Model 410C RANGE switch and the AC CALIBRATOR to the settings outlined in Table 5-8. Set the calibrator frequency to 400 Hz. Adjust the appropriate control for the required Model 410C reading. This completes the calibration procedure.

Table 5-8. AC Full Scale Adjust.

Model 410C Range	Voltmeter Calibrator AC Voltage Settings	Model 410C Reading ± 3%	Adjustment
.5 V	.50	.5 V	A6R3
1.5 V	1.5	1.5 V	A6R5
5 V	5	5 V	A6R7
*15 V	15	15 V	A6R14
*50 V	50	50 V	A6R14
*150 V	150	150 V	A6R14
*500 V	300	300 V	A6R14

*A6R14 is proper adjustment of Model 410C for RANGE settings from 15 V ac to 500 V ac. Select proper A6R14 setting which will provide best overall results for these ranges.

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

Before any repair is completed, ensure that all safety features are intact and functioning, and that all necessary parts are connected to their protective grounding means.

Note that the socket for the A3 board has dangerous voltages (+270V, +175V and +140V). See Figure 5-8, Amplifier Schematic.

5-40. Troubleshooting.

5-41. Preliminary Troubleshooting. Before you disassemble the instrument for troubleshooting, check the Model 410C on several functions and ranges. This can frequently lead or point to the source of trouble. For example, if the Model 410C fails on all ACV ranges but works correctly on all DCV ranges, the failure may lie in the 11036A AC probe or perhaps in the input switching network. If the problem exists only in the OHMS measurement mode, you should check the OHMS current source (i.e. A2R1, R2, R34; A7R10; R3 (rear panel) and the +6 volt supply).

5-42. Remove the power cord and top, bottom and side covers from the 410C and conduct a thorough visual inspection of the instrument. Look for overheated or loose components, loose connections, or any other obvious conditions which might indicate the source of trouble. You may wish to pull out the A3 board for a closer inspection. The A3 board edge connector contacts may be cleaned by rubbing them with a common pencil eraser.

5-43. Power Supply Troubleshooting.

5-44. A chart showing some of the more pertinent voltage and resistance values for the A7 Power Supply circuit board is given in Figure 5-6. This chart and the power supply schematic (Figure 5-7) may be used to troubleshoot and diagnose the power supply.

5-45. Amplifier Troubleshooting.

5-46. When analyzing amplifier problems, refer to the Block Diagram in Figure 4-1 and the Amplifier Schematic in Figure 5-8. Check all of the eleven DCV ranges to see if the input attenuator/switching, the A3 Amplifier Assembly, and the feedback/switching are functioning correctly. Perform these checks in the following manner.

a. Set the 410C Function Selector Switch to the +DCV position.

b. Connect a dc voltage source (Systron Donner Model M107 or equivalent) to the DCV and Com leads of the 410C.

c. Connect a dc voltmeter (-hp- Model 3466A or equivalent) to the DC Amplifier Output terminals on the 410C's back panel.

d. The DC Amplifier Output should read 1.5 V dc for each range with a full scale input. If the readings are not correct for all of the ranges, check the input attenuator/switching and feedback circuit paths for the defective range(s). (The Systron-Donner Model MI07 has a maximum output of 300 V dc so readings for the 500 V and 1500 V ranges will be less than 1.5 V dc unless a higher dc voltage source is used).

e. If all of the ranges read incorrect, check for +15 mV dc on pin 1 of the A3 board. If this reading is wrong, check the input attenuator/switching.

f. If the reading at pin 1 is correct, short pin 11 to pin 7 on the A3 board. If the voltage on pin 7 reads +15 mV (amplifier gain of 1; normal gain of amplifier is 100), the feedback circuit is defective. If pin 7 does not read +15 mV, op amp UI is most likely bad.

5-47. Schematic Diagrams.

5-48. The schematic diagrams (Figures 5-7 through 5-16) are divided into two groups: The Detailed schematics and the Simplified schematics that show the signal flow for the four measurement modes of operation (DCV, DCA, Ohms, and ACV). A pictorial wiring of the Function and Range switches is also given.

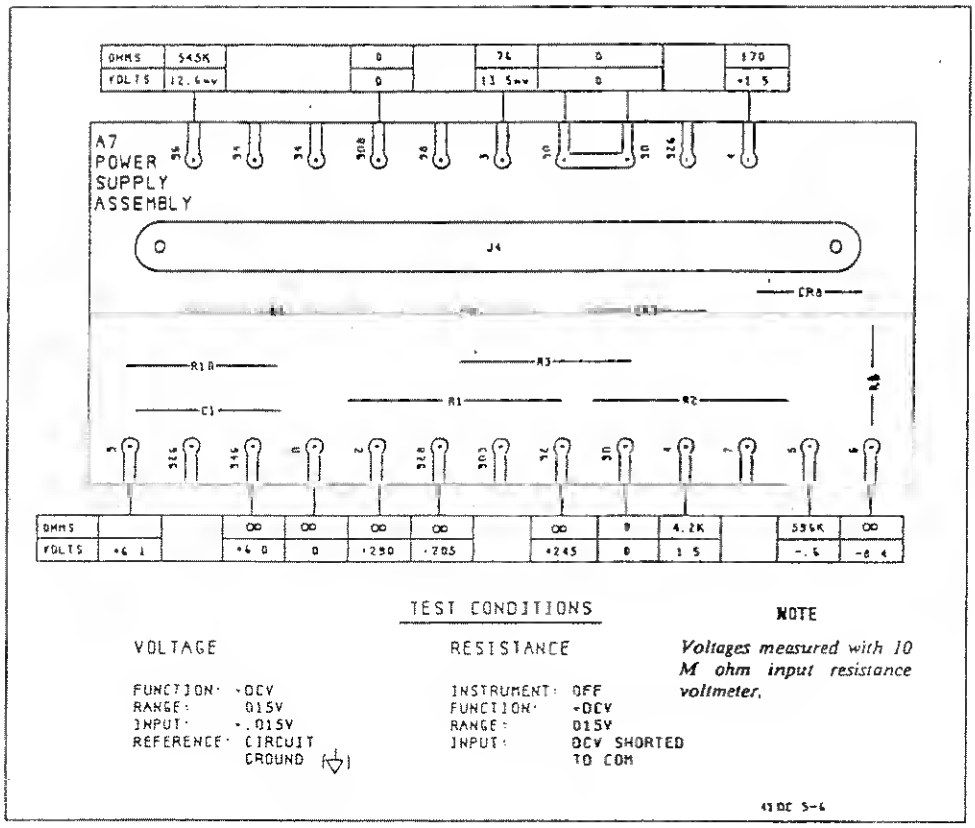
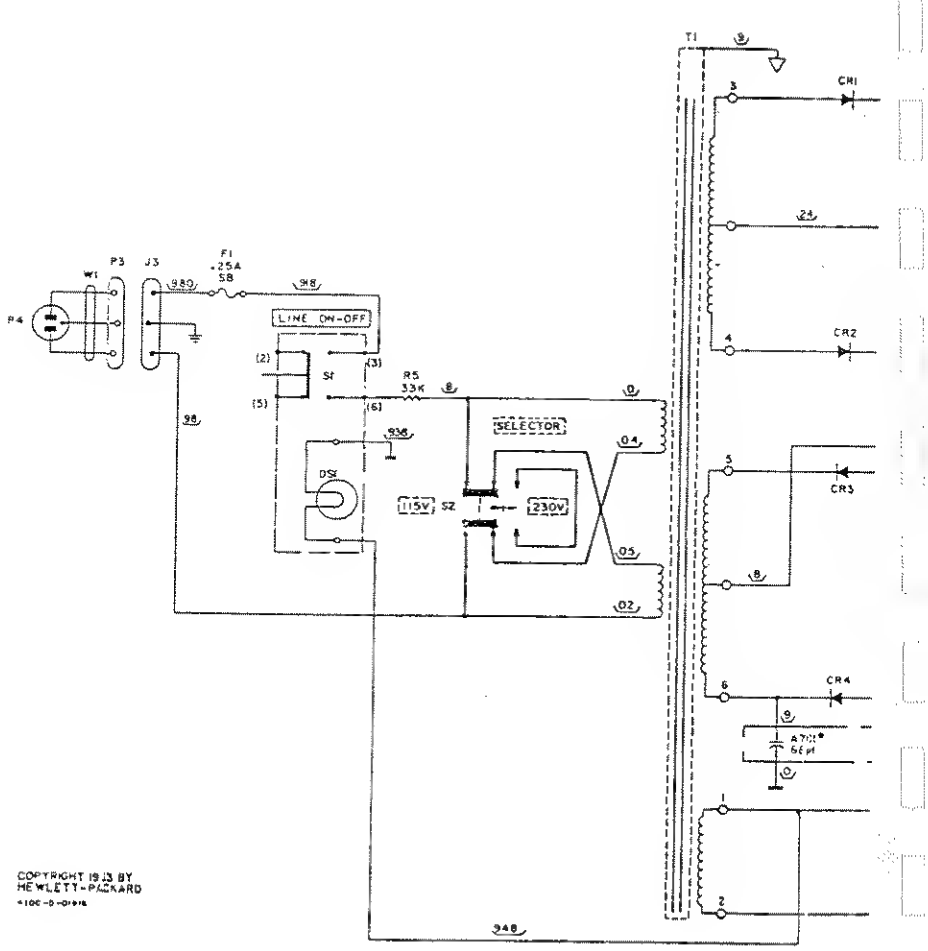
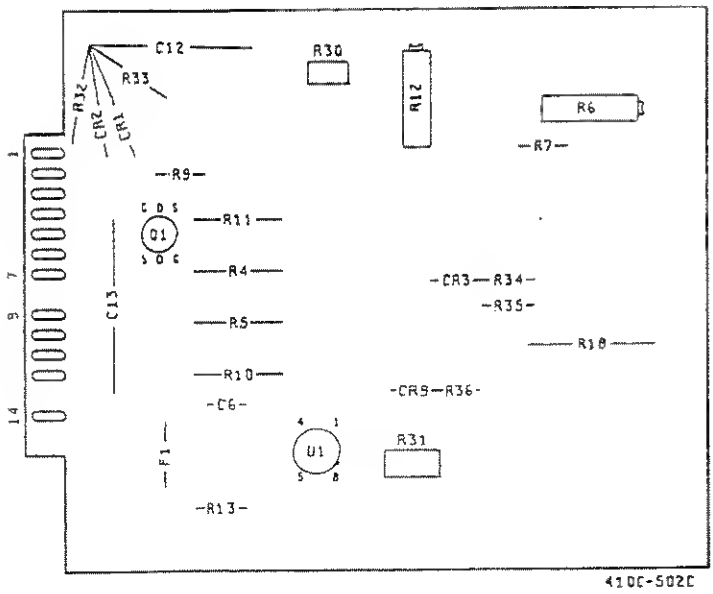


Figure 5-6. Power Supply Measurements.

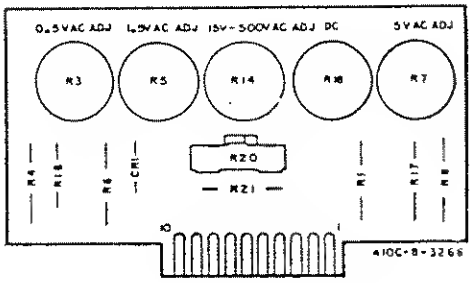
GENERAL SCHEMATIC NOTES

1. SWITCHES ARE SHOWN IN FULL CCW POSITIONS.
2. P/O = PART OF.
3. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS, UNLESS OTHERWISE SPECIFIED.
4. ⏚ = EARTH GROUND, ⊥ = CHASSIS GROUND. ▽ = CIRCUIT COMMON (FLOATING GROUND).
5. — — — — INDICATES AN ASSEMBLY. ALL COMPONENTS LOCATED ON AN ASSEMBLY ARE PREFIXED BY THE ASSEMBLY DESIGNATION (e.g., R3 ON ASSEMBLY A7 BECOMES A7R3).
6. — — — — — — — INDICATES SUBASSEMBLY.
7. — — — — — INDICATES DC FEEDBACK.
8. ◯ INDICATES PANEL ADJUST; ⊘ INDICATES SCREWDRIVER ADJUST.
9. \937/ INDICATES WIRE COLOR USING STANDARD COLOR CODE. (e.g., 8 = WHITE, 3 = ORANGE, 7 = VIOLET.)
10. * OPTIMUM VALUE SELECTED AT FACTORY. AVERAGE VALUE SHOWN.
11. ▭ INDICATES FRONT PANEL LOCATION. ▭ INDICATES REAR PANEL LOCATION.

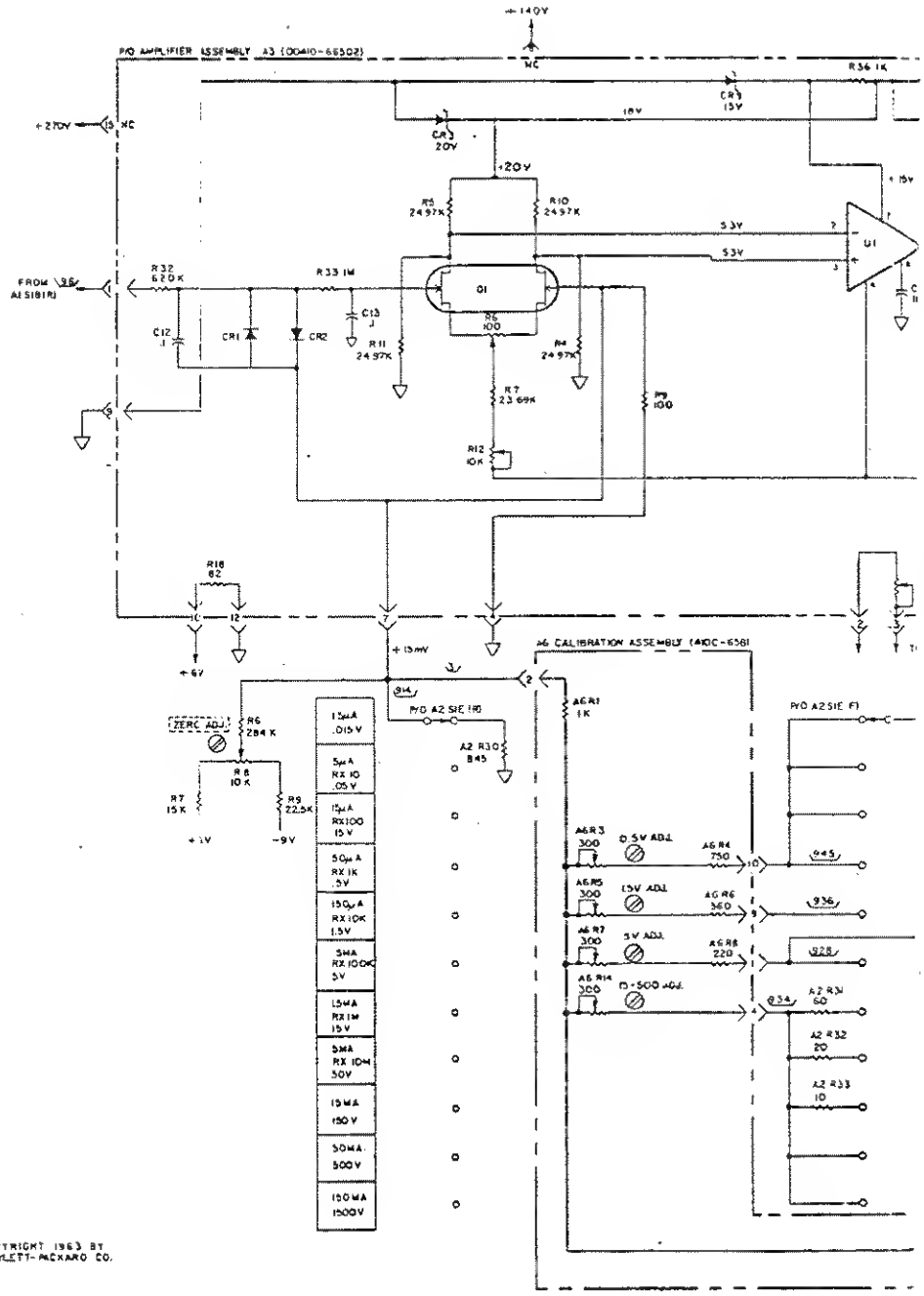




A3
hp Part No. 00410-66502



A6
hp Part No. 4101-658



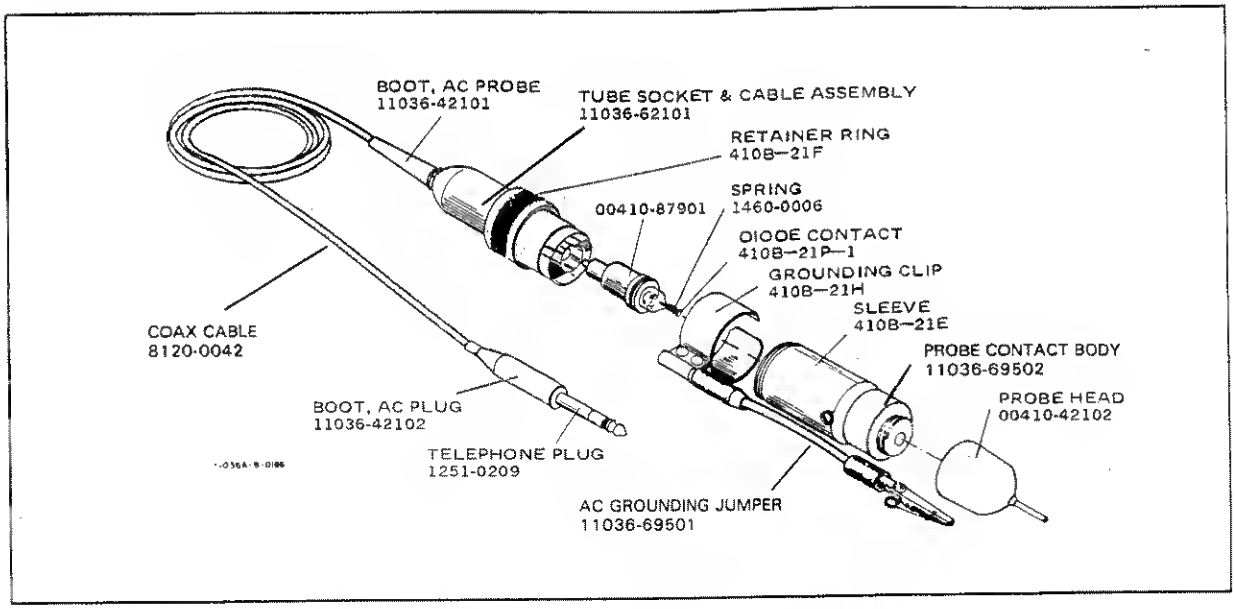
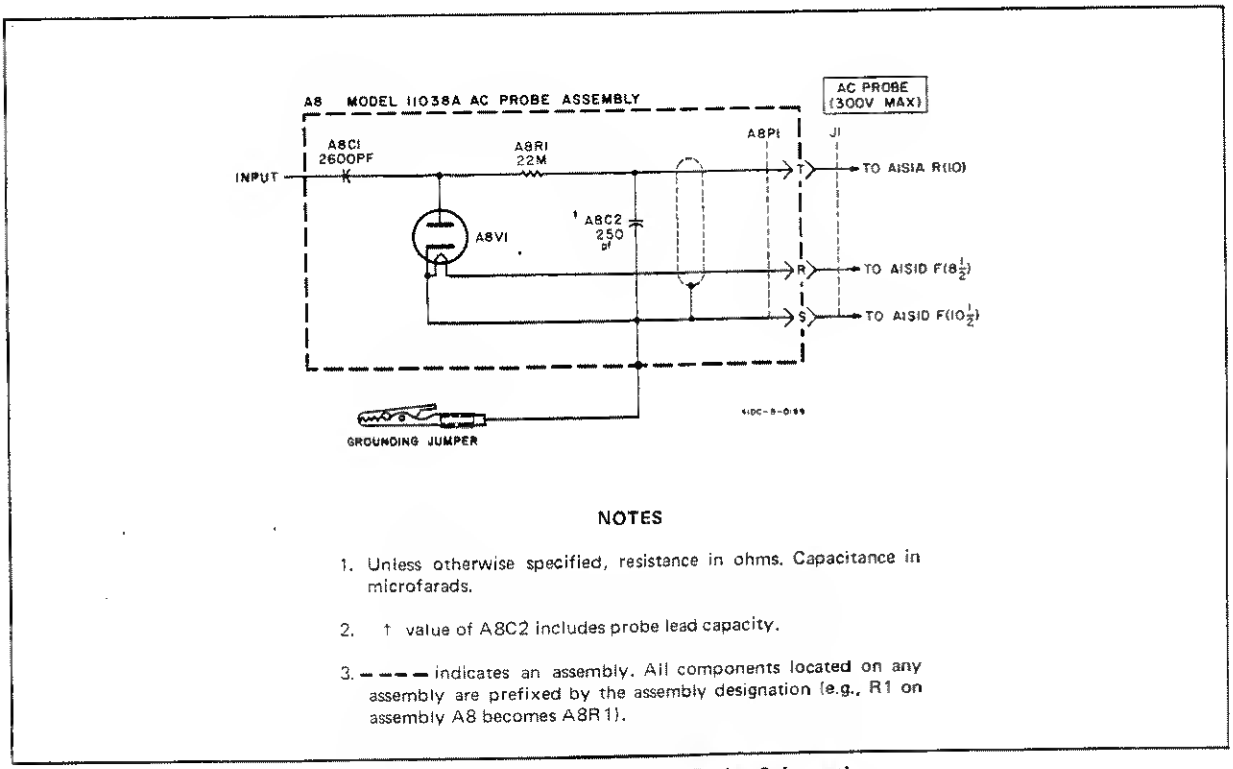


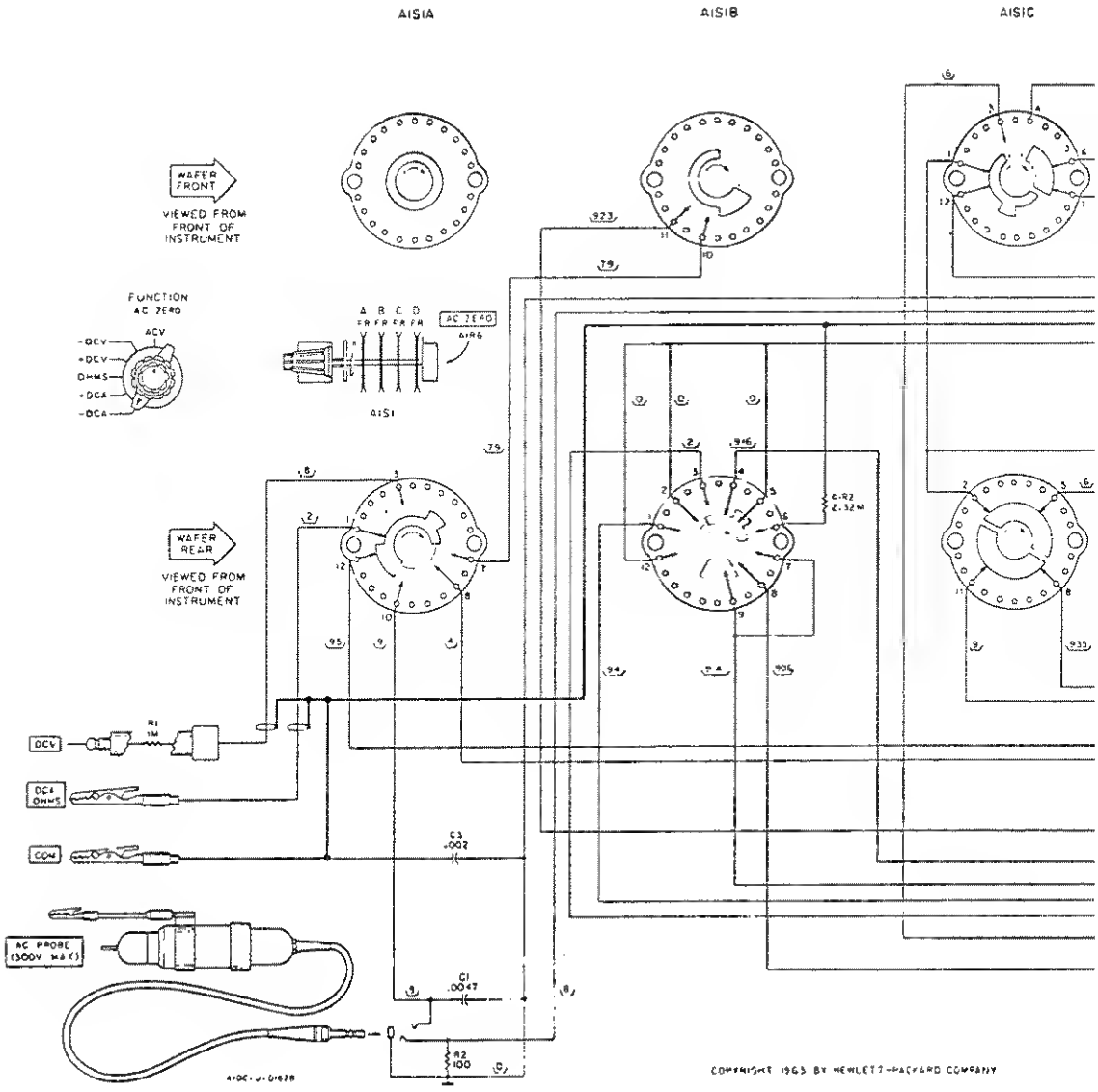
Figure 5-9. Model 11036A AC Probe (Exploded View).

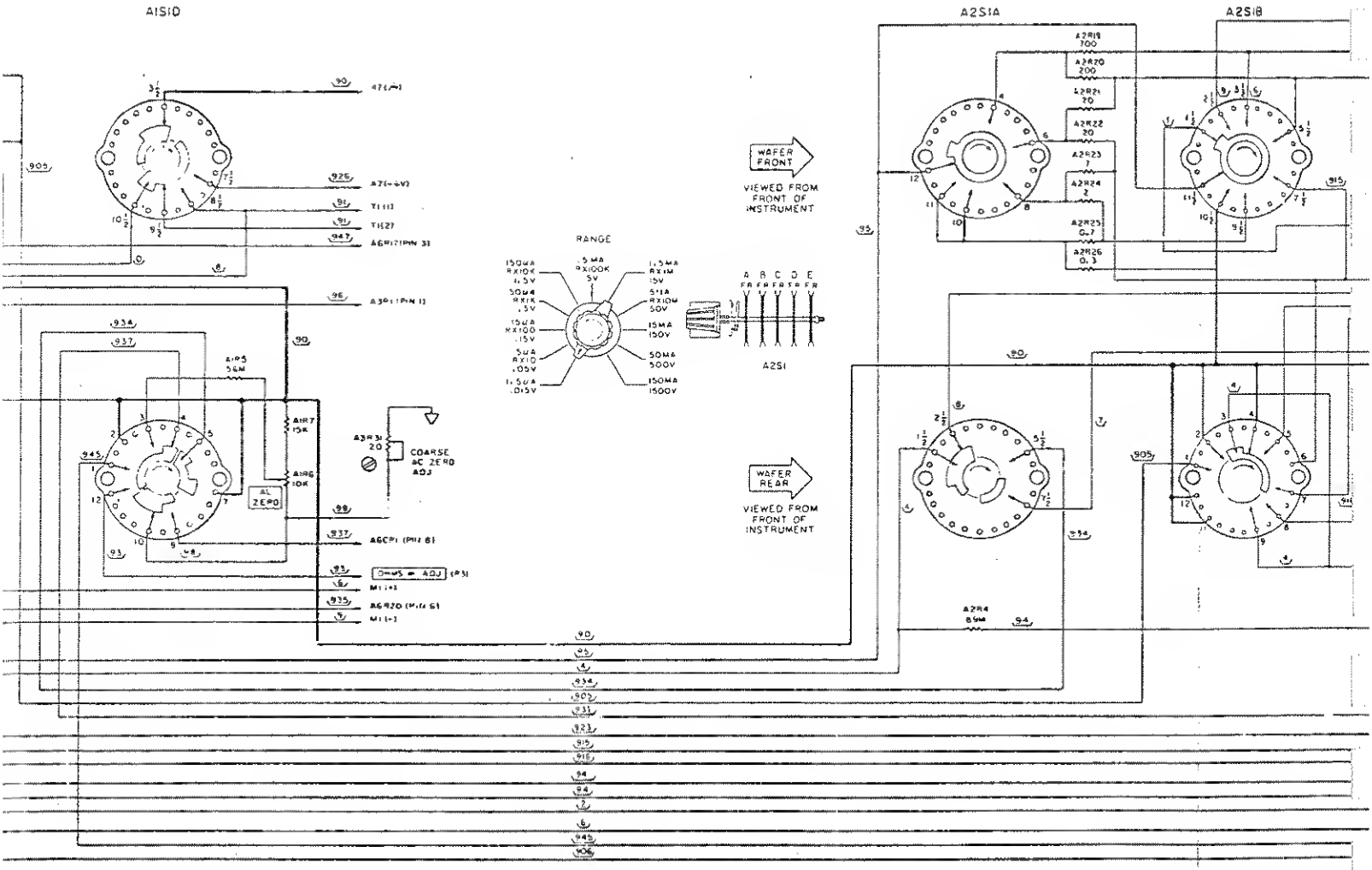


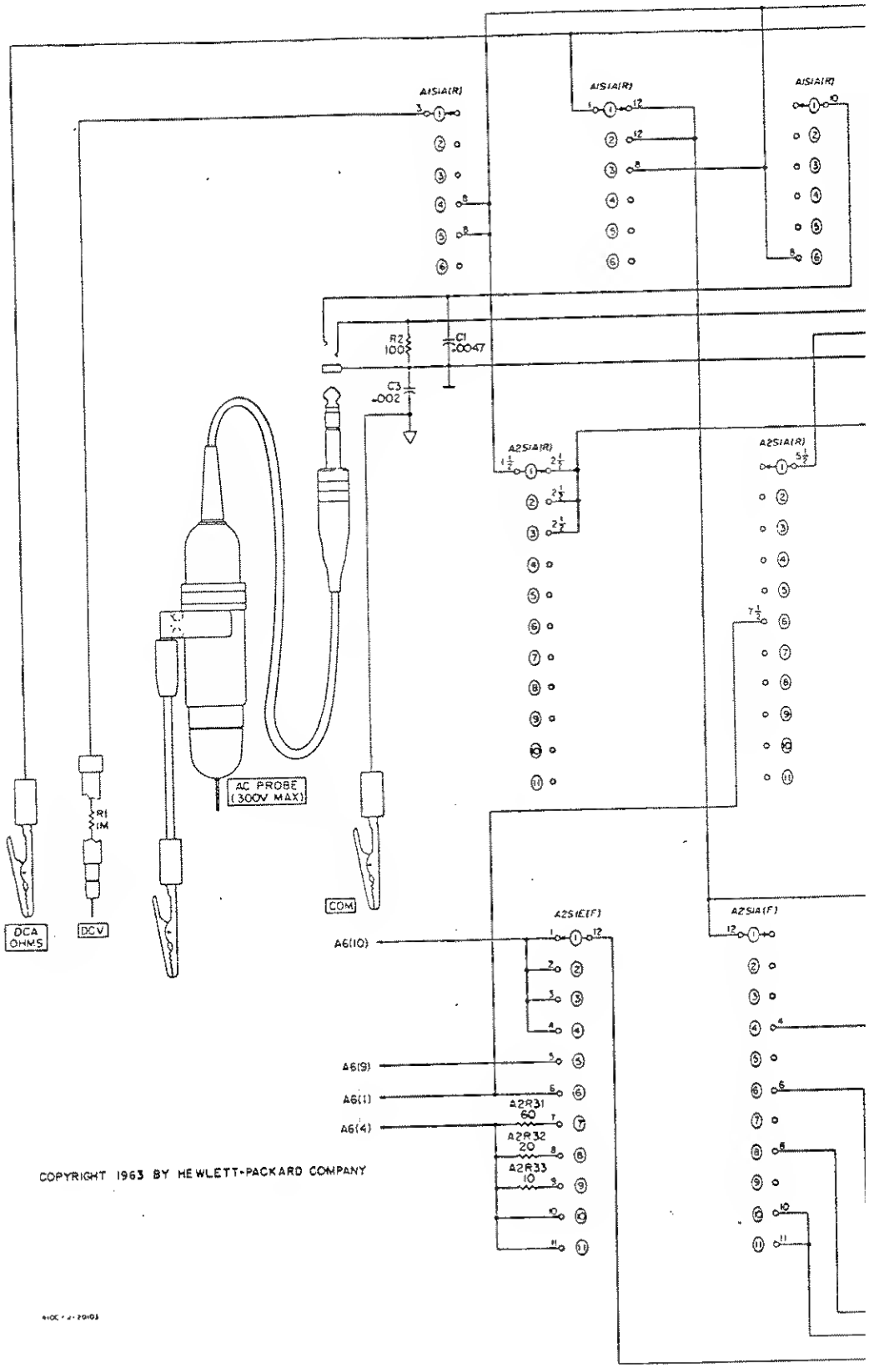
NOTES

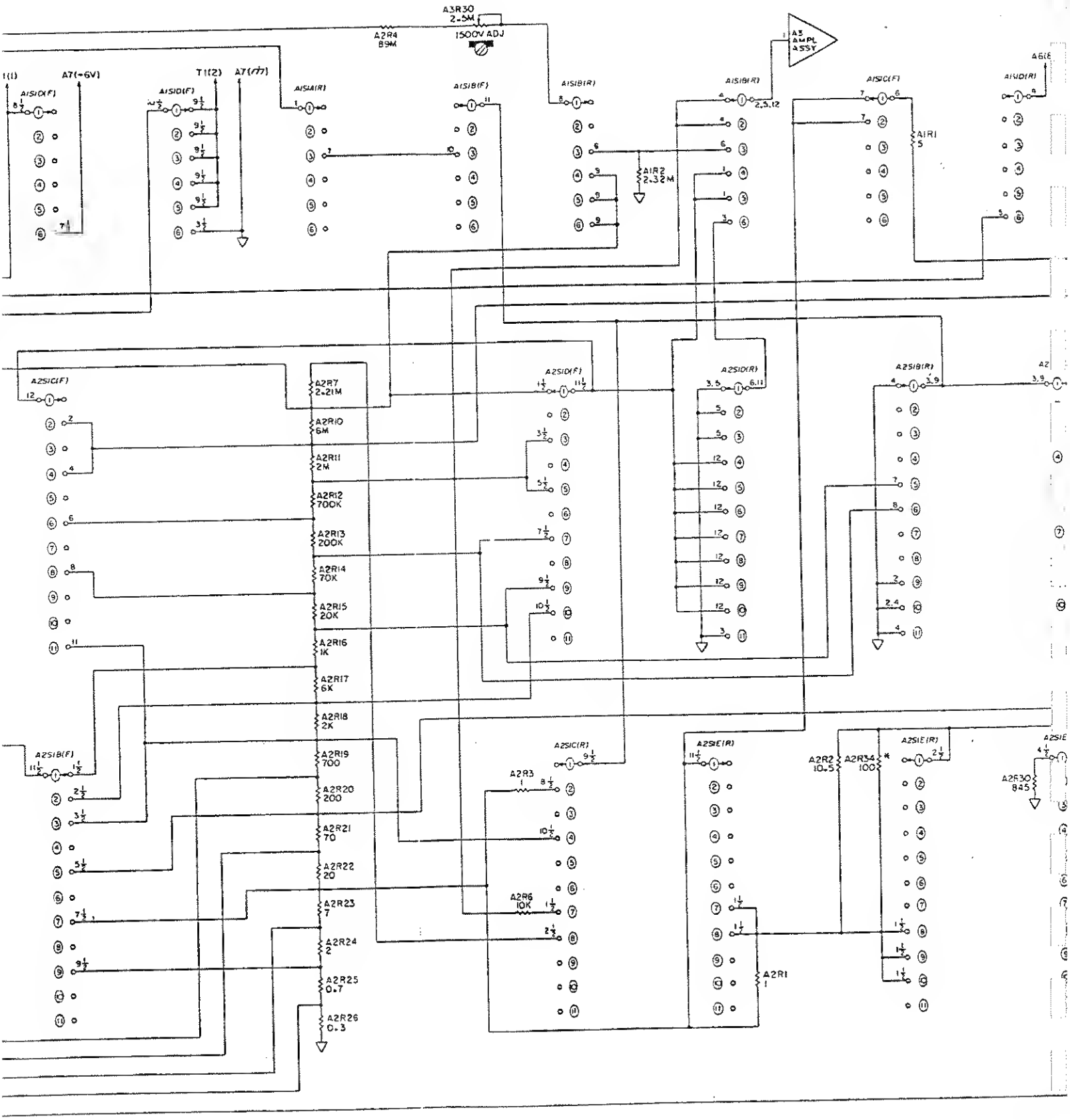
1. Unless otherwise specified, resistance in ohms. Capacitance in microfarads.
2. † value of A8C2 includes probe lead capacity.
3. – – – – indicates an assembly. All components located on any assembly are prefixed by the assembly designation (e.g., R1 on assembly A8 becomes A8R1).

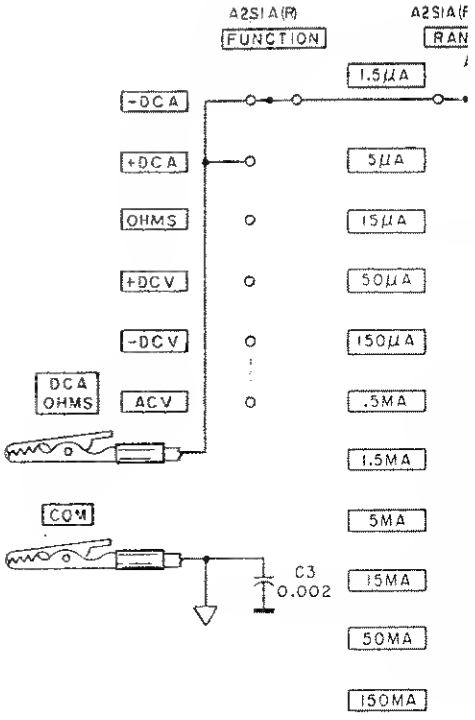
Figure 5-10. Model 11036A AC Probe Schematic.


A1S1A
A1S1B
A1S1C
WAFER FRONT
VIEWED FROM FRONT OF INSTRUMENT
FUNCTION
AC ZERO
ACV
-DCV
+DCV
OHMS
+DCA
-DCA
A B C D
AC ZERO
A1R6
A1S1
WAFER REAR
VIEWED FROM FRONT OF INSTRUMENT
R1
1M
R2
100
C1
.0047
C3
.002
C:R2
2.32M
DCV
DCA OHMS
COM
AC PROBE (300V MAX)
A10C+J+01628
COPYRIGHT 1963 BY HEWLETT-PACKARD COMPANY


A1S1D
A2S1A
A2S1B
RANGE
WAFER FRONT
VIEWED FROM FRONT OF INSTRUMENT
WAFER REAR
VIEWED FROM FRONT OF INSTRUMENT
A2S1
A1R5 56M
A1R7 15K
A1R8 10K
A3R31 20
COARSE ac ZERO ADJ
AC ZERO
A2R18 700
A2R20 200
A2R21 70
A2R22 20
A2R23 7
A2R24 2
A2R25 0.7
A2R26 0.3
A2R4 56M




A3R30
2-5M
1500V ADJ
A2R4
89M
A3
AMPL
ASSY
A7(+6V)
T1(2)
A7(77)
A1S1A(R)
A1S1B(F)
A1S1B(R)
A1S1C(F)
A1S1D(R)
A1R2
2.32M
A1R1
5
A2S1C(F)
A2S1D(F)
A2S1D(R)
A2S1B(R)
A2R7
2.21M
A2R10
6M
A2R11
2M
A2R12
700K
A2R13
200K
A2R14
70K
A2R15
20K
A2R16
1K
A2R17
6K
A2R18
2K
A2S1B(F)
A2S1C(R)
A2S1E(R)
A2R19
700
A2R20
200
A2R21
70
A2R22
20
A2R23
7
A2R24
2
A2R25
0.7
A2R26
0.3
A2R3
A2R6
10K
A2R1
1
A2R2
10.5
A2R34
100
A2R30
845


A2S1A(R)
FUNCTION
A2S1A(F
RAN
-DCA
+DCA
OHMS
+DCV
-DCV
ACV
DCA
OHMS
COM
1.5μA
5μA
15μA
50μA
150μA
.5MA
1.5MA
5MA
15MA
50MA
150MA
C3
0.002

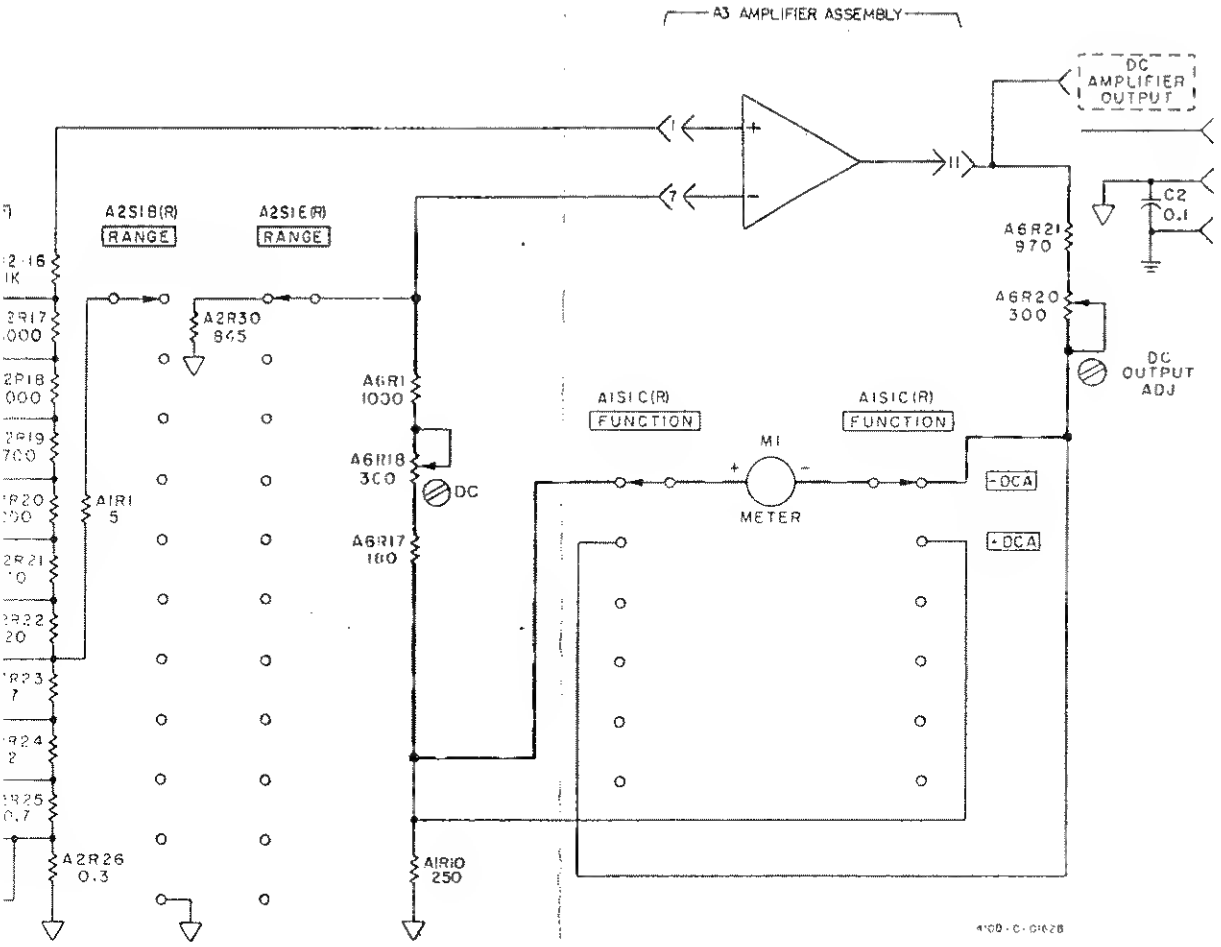
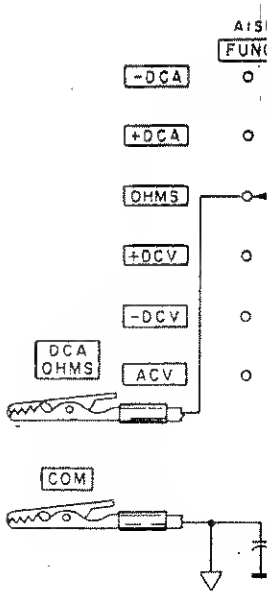


Figure 5-13. Simplified Schematic, DC Current Measurement.



*NOTE: THESE

4100-C-0161C

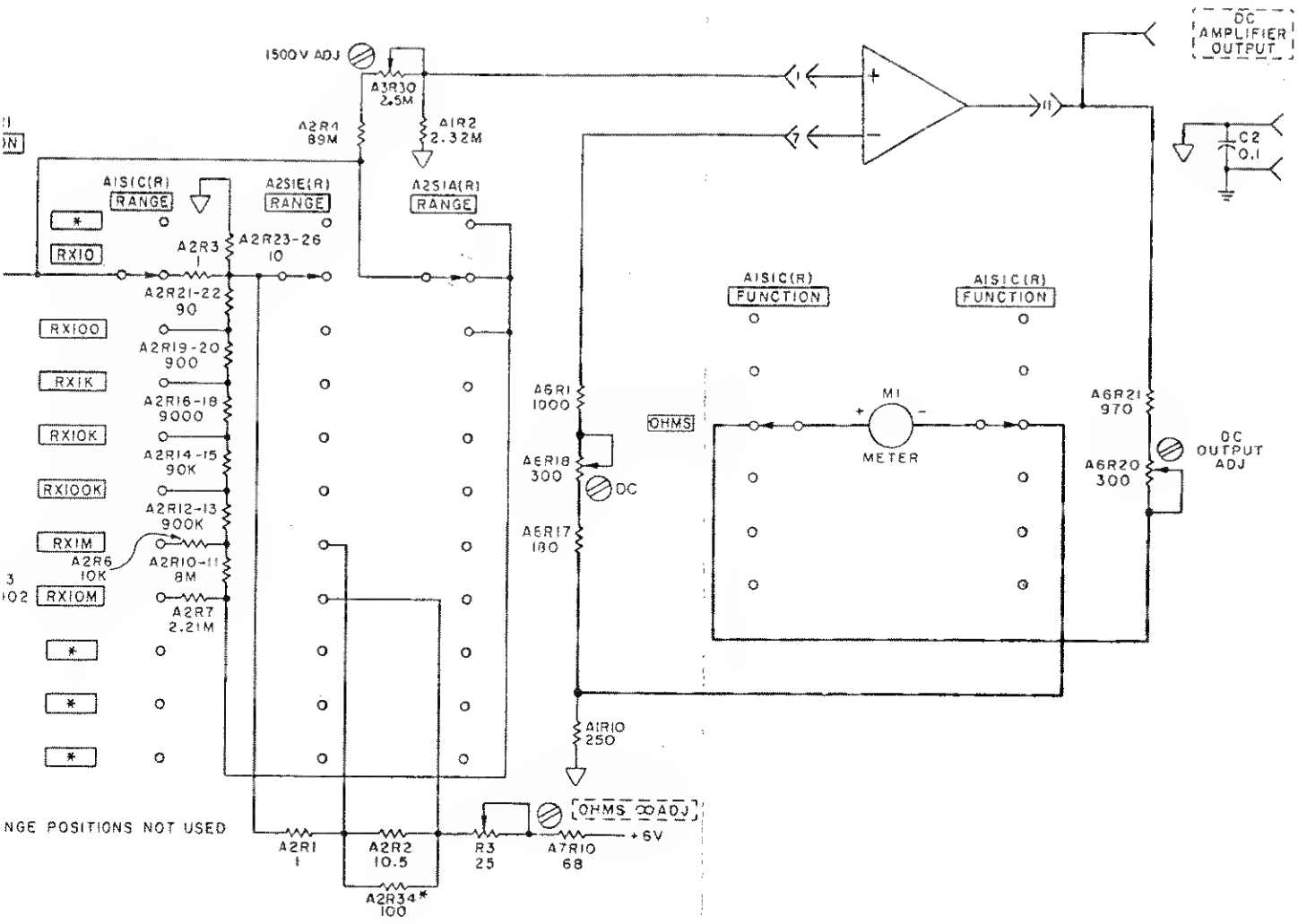


Figure 5-15. Simplified Schematic, Resistance Measurement.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations in Table 6-I.)

c. Typical manufacturer of the part in a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-3.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (Field Office Locations are listed at the back of the Manual.) Identify parts by their Hewlett-Packard Part Numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument Model Number

b. Instrument Serial Number

c. Description of the part.

d. Function and location of the part.

Table 6-1. List of Abbreviations.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycles) per second	NPO	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum	ID	inside diameter	ns	nanosecond(s) = 10^{-9} seconds	SPDT	single-pole double-throw
A	ampere(s)	impg	impregnated	nsr	not separately replaceable	SPST	single-pole single-throw
Au	gold	incd	incandescent			Ta	tantalum
C	capacitor	ins	insulation(ed)	Ω	ohm(s)	TC	temperature coefficient
cer	ceramic			obd	order by description	TiO_2	titanium dioxide
coef	coefficient	kΩ	kilohm(s) 10^{+3} ohms	OD	outside diameter	tog	toggle
com	common	kHz	kilohertz = 10^{+3} hertz			tol	tolerance
comp	composition			p	peak	trim	trimmer
conn	connection	L	inductor	pA	picoampere(s)	TSTR	transistor
		lin	linear taper	pc	printed circuit		
dep	deposited	log	logarithmic taper	pF	picofarad(s) 10^{-12} farads	V	volt(s)
DPDT	double-pole double-throw			piv	peak inverse voltage	vacw	alternating current working voltage
DPST	double-pole single-throw	mA	milliampere(s) = 10^{-3} amperes	p-o	part of	var	variable
		MHZ	megahertz 10^{+6} hertz	pos	positional	vdcw	direct current working voltage
elect	electrolytic	MΩ	megohm(s) = 10^{+6} ohms	poly	polystyrene		
encap	encapsulated	met flm	metal film	pot	potentiometer	W	watt(s)
		mfr	manufacturer	p-p	peak-to-peak	wr	with
F	farad(s)	ms	millisecond	ppm	parts per million	w/v	working inverse voltage
FET	field effect transistor	mtg	mounting	prec	precision (temperature coefficient, long term stability and/or tolerance)	wo	without
fxd	fixed	mV	millivolt(s) = 10^{-3} volts			ww	wirewound
		μF	microfarad(s)				
GaAs	gallium arsenide	μs	microsecond(s)	R	resistor		
GHz	gigahertz = 10^{+9} hertz	μV	microvolt(s) = 10^{-6} volts	Rh	rhodium	*	optimum value selected at factory, average value shown (part may be omitted)
gd	guarded	my	Mylar ®	rms	root-mean square	**	no standard type number assigned selected or special type
Ge	germanium			rot	rotary		
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes	Se	selenium		
		NC	normally closed	sect	section(s)		® Dupont de Nemours
H	henry(ies)	Ne	neon	Si	silicon		
Hg	mercury	NO	normally open				

DESIGNATORS

A	assembly	FL	filter	Q	transistor	TS	terminal strip
B	motor	HR	heater	QCR	transistor-diode	U	microcircuit
BT	battery	IC	integrated circuit	R(p)	resistor(pack)	V	vacuum tube, neon bulb, photocell, etc.
C	capacitor	J	jack	RT	thermistor	W	cable
CR	diode or thyristor	K	relay	S	switch	X	socket
DL	delay line	L	inductor	T	transformer	XDS	lampholder
DS	lamp	M	meter	TB	terminal board	XF	fuseholder
E	misc electronic part	MP	mechanical part	TC	thermocouple	Y	crystal
F	fuse	P	plug	TP	test point	Z	network

Table 6-2. Code List of Manufacturers.

Manufacturer No.	Manufacturer Name	Address
H9027	Schurter AGH	Luzern, SW
00853	Sangamo Elect Co.	Pickens, SC 29671
01121	Allen-Bradley Co.	Milwaukee, WI 53204
04713	Motorola Semiconductor Products	Phoenix, AZ 85062
07088	Kalvin Electric Co.	Van Nuys, CA 91401
07263	Fairchild Semiconductor Corp. Div.	Mountain View, CA 94042
08806	GE Co. Miniature Lamp Prod. Dept.	Cleveland, OH 44112
09023	Cornell-Dubilier Elek Div.	Sanford, NC 27330
09134	Taxes Capacitor Co. Inc.	Houston, TX 77038
10582	CTS of Asheville Inc.	Skyland, NC 28776
11502	TRW Inc. Boone Div.	Boone, NC 28607
14936	General Instr. Semicon Prod.	Hicksville, NY 11802
1S554	VLN Corp, Victoreen Inst. Div.	Cleveland, OH 44103
19701	Mepco/Electra Corp.	Mineral Wells, TX 19701
28365	Gries Reproducer Corp.	New Rochelle, NY 10802
28742	Methode Electronics Inc.	Chicago, IL 60656
27014	Natl Semiconductor Corp.	Sante Clara, CA 95051
28480	Hewlett-Packard Co. Corporate Hq.	Palo Alto, CA 94304
28S20	Heymen Mfg. Co.	Kentworth, NJ 07033
30983	Mepco/Electra Corp.	San Diego, CA 92121
34263	CTS of Browneville Inc.	Browneville, TX 78520
58137	Spaulding Fiber Co. Inc.	Tonawanda, NY 14150
56289	Sprague Electric Co.	North Adams, MA 01247
70371	3-M Tech Ceramics Products Div.	Chattanooga, TN 37405
71400	Bussman Mfg. Div. of McGraw Edison Co.	St. Louis, MO 63107
71785	TRW Elect Comp. Clinch Div.	Elk Grove Vlge, IL 60007
73138	Beckman Inst. Inc. Helipot Div.	Fullerton, CA 92634
73734	Federal Screw Products Co.	Chicago, IL 60618
7S915	Littlefuse Inc.	Des Plaines, IL 60018
78854	Oak Ind. Inc. SW Div.	Crystal Lake, IL 60014
78189	Illinois Tool Works	Elgin, IL 60128
78S53	Tinnerman Products	Cleveland, OH 44101
82389	Switchcraft Inc.	Chicago, Il 60630
83259	Parker Seal Co, Div. Parker Hannifin	Lexington, KY 90231
84411	TRW Capacitor Div.	Ogallala, NE 69153
91637	Dale Electronics Inc.	Columbus, NE 68601
91260	Conner Spring & Mfg. Co.	San Jose, CA 95112
97913	Industrial Electronic Hardware Corp.	New York, NY 10012

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	410C-198		1	SWITCH ASSEMBLY: FUNCTION	28480	410C-198
R1	0727-0004	4	1	R:FXD C FLM 5Ω ± 1% 1/2W	91637	DCS-1/2-15
R2	0727-0480	4	1	R:FXD C FLM 2.32 MΩ ± 1% 0.5W	91637	DCS-1/2-2324-F
R3, R4				NOT ASSIGNED		
R5	0687-5661	1	2	R:FXD COMP 56 MΩ ± 10% 1/2W	01121	EB5661
R6	2100-0389	4	1	R:VAR WW LIN 10 KΩ ± 10% 1W	02460	AW
R7	0687-1531	1	1	R:FXD COMP 15 KΩ ± 10% 1/2W	01121	EB1531
R8, R9				NOT ASSIGNED		
R10	0727-0479	4	1	R:FXD C FLM 250 Ω ± 1% 1/2W	91637	DCS1/2-251-F
S1	3100-0383	1	1	SWITCH: ROTARY 4-SECTION 6-POSITION (FUNCTION)	76854	5-44643-563
A2	410C-19A			SWITCH ASSEMBLY: RANGE	28480	410C-19A
R1	0728-0004	4	2	R:FXD C FLM 1 Ω ± 1% 1/2W	91637	DCS-1/2-15
R2	0727-0955	4	1	R:FXD C FLM 10.5 Ω ± 1% 1/2W	91637	DCS-1/2-15
R3	0728-0004	4		R:FXD C FLM 1 Ω ± 1% 1/2W	91637	DCS-1/2-15
R4	0733-0018	1	1	R:FXD C FLM 89 MΩ ± 1% 2W	15554	RX-3
R5				NOT ASSIGNED		
R6	0687-1031	1	1	R:FXD COMP 10 KΩ ± 10% 1/2W	01121	EB1031
R7	0727-0478	4	1	R:FXD C FLM 2.21 MΩ ± 1% 1/2W	91637	DCS1/2-2214-F
R8, R9				NOT ASSIGNED		
R10	0730-0176	4	1	R:FXD C FLM 6 MΩ ± 0.5% 1W	91637	DC1-6004-D
R11	0727-0459		1	R:FXD C FLM 2 MΩ ± 0.5% 1W	91637	DC1-2004-D
R12	0727-0458	4	1	R:FXD C FLM 700 KΩ ± 0.5% 1/2W	91637	DCS1/2-7003-D
R13	0727-0457	4	1	R:FXD C FLM 200 KΩ ± .5% 1/2 W	91637	DCS1/2-2003-D
R14	0727-0456	4	1	R:FXD C FLM 70 KΩ ± 0.5% 1/2W	91637	DCS1/2-7002-D
R15	0727-0455	4	1	R:FXD C FLM 20 KΩ ± 0.5% 1/2W	91637	DCS1/2-2002-D
R16	0727-0451	4	1	R:FXD C FLM 1000 Ω ± 0.5% 1/2W	91637	DCS1/2-1001-D
R17	0727-0454	4	1	R:FXD C FLM 6800 Ω ± 0.5% 1/2W	91637	DCS1/2-6801-D
R18	0727-0453	4	1	R:FXD C FLM 2000 Ω ± 0.5% 1/2W	91637	DCS1/2-2001-D
R19	0727-0452	4	1	R:FXD C FLM 700 Ω ± 0.5%1/2W	91637	DCS1/2-701-D
R20	0727-0450	4	1	R:FXD C FLM 200 Ω ± 0.5% 1/2W	91637	DCS1/2-201-D
R21	0727-0449	4	1	R:FXD C FLM 70Ω ± 1% 1/2W	91637	DCS-1/2-15
R22	0727-0448	4	2	R:FXD C FLM 20 Ω ± 1% 1/2W	91637	DCS1/2-20R0-F
R23	0727-0446	4	1	R:FXD C FLM 7 Ω ± 1% 1/2W	91637	DCS-1/2-15
R24	0727-0445	4	1	R:FXD C FLM 2 Ω ± 1% 1/2W	91637	DCS-1/2-15
R25	410C-26B		1	R:FXD 0.7 Ω	28480	410C-26B
R26	410C-26A		1	R:FXD 0.3 Ω	28480	410C-26A
R27 THRU R29				NOT ASSIGNED		
R30	0727-0701	4	1	R:FXD C FLM 845 Ω ± 1% 1/2W	91637	DCS-1/2-845R-F
R31	0727-0031	4	1	R:FXD C FLM 60 Ω ± 1% 1/2W	91637	DCS-1/2-15
R32	0727-0448	4		R:FXD C FLM 20 Ω ± 1% 1/2W	91637	DCS-20R0-F
R33	0727-0948	4	1	R:FXD C FLM 10 Ω ± 1% 1/2W	91637	DCS1/2-10R0-F
R34*	0687-1011	1	1	R:FXD COMP 100 Ω ± 10% 1/2W	01121	EB1011
S1	3100-0382	1	1	SWITCH: ROTARY 5-SECTION 11-POSITION (RANGE)	76854	5-43633-561
A3	00410-66502		1	ASSEMBLY; AMPLIFIER	28480	00410-66502
C6	0160-2204	2	1	C:FXD 100 PF 300V	00853	RDM15F101J3C
C12	0160-4402	3	1	C:FXD .1UF .10 100V	84411	HEW446
C13	0160-4402	3	1	C:FXD .1UF .10 100V	84411	HEW446
CR1	1901-0040	6	2	DIODE: SI .05A 30V	07263	FOH1088
CR2	1901-0040	6		DIODE: SI .05A 30V	07263	FOH1088
CR3	1902-0556	0	1	DIODE: BREAKDOWN 20V 5%	04713	SZ11213-227
CR9	1902-0202	0	1	DIODE: BREAKDOWN 15V 5%	04713	SZ11213-193
F1	2110-0077	5	1	FUSE: 1/8 A	75915	276.125
Q1	1855-0246	6	1	TRANSISTOR: JFET DUAL N-CHAN	27014	SF83075
R4	0811-2845	2	4	R: FXD 24.97K .025% .25W	07088	KP130
R5	0811-2845	2		R: FXD 24.97K .025% .25W	07088	KP130
R6	2100-3122	2	1	R: TRMR 100 10% 17 TURN	73138	89PR100
R7	0698-7670	9	1	R: FXD 23.69K .1% .125W	19701	MF4C 1/8-T2-23691-B
R9	0698-6323	4	1	R: FXD 100 .1% .125W	91637	CMF-55-1,T-9
R10	0811-2845	2		R: FXD 24.97K .025% .25W	07088	KP130
R11	0811-2845	2		R: FXD 24.97K .025% .25W	07088	KP130
R12	2100-3103	2	1	R: TRMR 10K 10% 17 TURN	73138	89PR10K
R13	0757-0401	9	1	R: FXD 100 1% .125W	19701	MFNC-1
R18	0698-3618	2	1	R: FXD 82 5% 2W	11502	GS-3
R30	2100-3854	7	1	R: TRMR 2.5M 20% 1-TRN	30983	8017SMW2.5M
R31	2100-3426	2	1	R: TRMR 20 10% 1-TRN	73138	72XR20
R32	0683-6245	1	1	R: FXD 620K 5% .25W	01121	CB6245
R33	0683-1055	1	1	R: FXD 1M 5% .25W	01121	CB1055
R34	0683-6225	1	2	R: FXD 6.2K 5% .25W	01121	CB6225
R35	0683-6225	1		R: FXD 6.2K 5% .25W	01121	CB6225
R36	0683-1025	1	1	R: FXD 1K 5% .25W FC TC=400/+600	01121	CB1025
U1	1826-0035	6	1	IC OP AMP	27014	LM308AH

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4, A5				NOT ASSIGNED		
A6	410C-65B			ASSEMBLY: CALIBRATION	28480	410C-65B
CR1	1901-0025	6	1	DIODE: SI 50 MA	07263	FDH536
R1	0727-0751	4	1	R:FXD C FLM 1000 Ω ± 1% 1/2W	91637	DCS-1/2-15
R2				NOT ASSIGNED		
R3	2100-0394	4	5	R:VAR WW LIN 300 Ω ± 20% 1W	10582	SERIES 110
R4	0727-0747	4	2	R:FXD C FLM 750 Ω ± 1% 1/2W	91637	DCS1/2-751-F
R5	2100-0394	4		R:VAR WW LIN 300 Ω ± 20% 1W	10582	SERIES 110
R6	0728-0011	4	1	R:FXD C FLM 360 Ω ± 1% 1/2W	91637	DCS1/2-361-F
R7	2100-0394	4		R:VAR WW LIN 300 Ω ± 20% 1W	10582	SERIES 110
R8	0728-0010	4	1	R:FXD C FLM 220 Ω ± 1% 1/2W	91637	DCS-1/2-15
R9 THRU R13				NOT ASSIGNED		
R14	2100-0394	4		R:VAR WW LIN 300 Ω ± 20% 1W	10582	SERIES 110
R15				NOT ASSIGNED		
R16	0698-5865	4	1	R:FXD 8.25K 1% .25W	91637	CMF-60-1,T-9
R17	0727-0866	4	1	R:FXD C FLM 180 Ω ± 1% 1/2W	91637	DCS1/2-180-F
R18	2100-0394	4		R:VAR WW LIN 300 Ω ± 20% 1W	10582	SERIES 110
R19				NOT ASSIGNED		
R20			1	R:VAR COMP LIN 500 Ω ± 20% 1/4W		
R21	0727-0475	4	1	R:FXD C 970 Ω ± 0.5% 1/2W	91637	DCS-1/2-15
A7	410C-65E			ASSEMBLY: POWER SUPPLY	28480	410C-65E
C1*	0140-0025	2	1	C: FXD MICA 68PF ±10% 500 VDC	00853	RCM15E680K
CR1 THRU CR5				NOT ASSIGNED		
CR6	1902-0026	0	1	DIODE: BREAKDOWN 36.5V ±10% 0.4W	04713	SZ30016-343
CR7	1902-3149	0	1	DIODE: BREAKDOWN 9.09V 5% DO-7	04713	SZ30016-170
CR8	1902-0048	0	1	DIODE: BREAKDOWN 6.81V 5% DO-7	04713	SZ30016-134
J4	1251-0213	4	1	CONNECTOR: 15 PIN PC	26742	91-6915-1700-00
R1,R2	0764-0003	2	2	R: FXD MET FLM 3300 ±5% 2W	11502	GS-3
R3	0757-0757	9	1	R: FXD 15K 1% .25W	19701	MF52C-1
R4	0764-0026	2	1	R: FXD MET FLM 13K ±5% 2W	11502	GS-3
R5,R6				NOT ASSIGNED		
R8	0757-0334	9	1	R: FXD 301 1% .25W	19701	MF52C-1
R9				NOT ASSIGNED		
R10	0757-0709	9	1	R: FXD MET FLM 68.1 1% .25W	19701	MF52C-1
A8	11036A			ASSEMBLY: AC PROBE (HP MODEL 11036A, COMPLETE)	28480	11036A
C1				NOT SEPARATELY REPLACEABLE, PART OF AC PROBE (11036A)		
C2				NOT SEPARATELY REPLACEABLE, PART OF AC PROBE (11036A)		
P1	1251-0209	5	1	PLUG: TELEPHONE 3 CONDUCTOR	82389	2P-1297
R1				NOT SEPARATELY REPLACEABLE, PART OF AC PROBE (11036A)		
V1	00410-87901			TUBE: ELECTRON DIODE	28480	00410-87901
C1	0170-0021	3	1	C:FXD MY 4700 PF ± 10% 400 VDCW	84411	663UW47294
C2	0170-0022	6	1	C:FXD MY 0.1 µF ± 10% 600 VDCW	09134	TYPE 24
C3	0150-0023	2	1	C:FXD CER 2000 PF ± 20% 1000 VDCW	56289	20C295A2-CDM
C4				NOT ASSIGNED		
C5	0180-0025	2	1	C:FXD AL ELECT 4X20 µF +50% -10% 450 VDCW	56289	D32452DFP
C6	0180-0153	2	1	C:FXD AL ELECT 2X1200 µF +100% -10% 20 VDCW	56289	D37303DFP
CR1, CR2	1901-0036	6	1	DIODE:HV RECT 1KV 600MA	14936	MP496
CR3, CR4	1901-0049	0	1	DIODE:PWR RECT 50V 750MA	04713	SR1338-6
DS1	2140-0458	0	1	LAMP-INCAND 6.3 VDC 40MA	08806	380
F1	2110-0201	0		FUSE: 0.25A 250V	71400	MDL-1/4
J1	1251-0200	5	1	JACK: TELEPHONE 3 CONDUCTOR	82389	5J-1291A
J2				ASSEMBLY: DC AMPLIFIER OUTPUT (SEE MISCELLANEOUS FOR PART NOS.		
J3	1251-2357	5	1	CONNECTOR: POWER CORD RECEPTACLE	82389	EAC-301
M1	1120-0317		1	METER: 0-1 MA	28480	1120-0317
Q1	1853-0063	0	1	TSTR: SI PNP	04713	SJY407

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8 (CONT'D)						
R1	0727-0274	4	1	R:FXD C FLM 1 MΩ ± 1% 1/2W	91637	DCS1/2-1004-F
R2	0757-0401	9	1	R:FXD 100 1% .125W	19701	MF4C-1
R3	2100-0415	4	1	R:VAR WW LIN 25 Ω ± 10% 2W	10582	117
R4,R5				NOT ASSIGNED		
R6	0727-0231	4	1	R:FXD 284K ± 0.5% 1/2W	91637	DCS-1/2-15
R7	0727-0168	4	1	R:FXD 15K Z 1% 1/2W	91637	DCS-1/2-15
R8	2100-1567	4	1	R:TRMR 10K 10%	10582	117
R9	0727-0180	4	1	R:FXD 25.5K	91637	DCS-1/2-15
S1	3101-1248	1	1	SWITCH: SPST PUSHBUTTON (LINE)	76854	53-55480-121-A1H
S2	3101-1234	5	1	SWITCH: DPDT SLIDE (SLECTOR)	82389	11A-1242A
T1	9100-0174	2		TRANSFORMER: POWER 115/230V	28480	9100-0174
W1	8120-1348	2	1	CABLE: POWER 3 CONDUCTOR 7-1/2 FT. LONG	28480	8120-1348
XQ1	1200-0044	3	1	SOCKET: TRANSISTOR TO-3	97913	LST1502-3

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				MISCELLANEOUS		
	1490-0088	0	1	CLIP: GROUND	71785	422-11-11-095
	1510-0084	2	2	BINDING POST	28480	1510-0084
	1510-0087	2	1	BINDING POST ASSEMBLY	28480	1510-0087
	0340-0732	2	5	INSULATOR BINDING POST	28480	0340-0732
	11036-42102	2	1	BOOT: AC PLUG (P/O 11036A)	28480	11036-42102
	11036-42101	2	1	BOOT: AC PROBE (P/O 11036A)	28480	11036-42101
	412A-83A	2	3	BOOT: CABLE	28480	412A-83A
	410C-12B	2	1	BRACKET: SWITCH (USED WITH A6 CONNECTOR)	28480	410C-12B
	00410-01202		2	BRACKET: COVER RETAINER	28480	00410-01202
	410C-12A	2	1	BRACKET: CONNECTOR (USED WITH A3 CONNECTOR)	28480	410C-12A
	1200-0081	3	2	BUSHING: INSULATOR (USED WITH Q1)	26365	974 SPECIAL
	1410-0091	1	2	BUSHING: PANEL (USED WITH A1S1 AND A2S2)	28520	SB-437-4
	0400-0019	2	3	BUSHING: STRAIN RELIEF	28480	0400-0019
	410C-1A	2	1	CHASSIS: TRANSFORMER	28480	410C-1A
	410B-21H	2	1	CLIP: GROUNDING (P/O 11036A)	28480	410B-21H
	410B-21P	2	1	CONTACT: DIODE (P/O 11036A)	28480	410B-21P
	3130-0038	1	1	COUPLER: SWITCH-ROTARY	76854	365PL-H3
	5000-8565		1	COVER: SIDE	28480	5000-8565
	00410-64102		1	COVER: TOP (REQUIRES 2 BRACKETS 00410-01202)	28480	00410-64102
	5000-8571		1	COVER: BOTTOM	28480	5000-8571
	5060-0727		2	FOOT ASSEMBLY	28480	5060-0727
	5060-0703		2	FRAME: SIDE	28480	5060-0703
	5040-0708		2	HINGE (USED WITH TILT STAND)	28480	5040-0708
	1400-0089		1	INSULATOR: CLIP (P/O 11036A)	28480	1400-0089
	0340-0686		1	INSULATOR: BINDING POST DOUBLE	28480	0340-0686
	0340-0091		1	INSULATOR: BINDING POST TRIPLE	28480	0340-0091
	1520-0001	6	2	INSULATOR: CAPACITOR (USED WITH C1-C2)	56137	XP
	0340-0807	0	1	INSULATOR: CERAMIC STANDOFF	70371	
	0370-0112	2	1	KNOB: BLACK BAR CONCENTRIC	28480	0370-0112
	0370-0113	2	1	KNOB: BLACK BAR W/ARROW	28480	0370-0113
	0370-0114	2	1	KNOB: RED W/ARROW	28480	0370-0114
	0360-0016	8	1	LUG: SOLDER LOCK #4	78189	
	0360-0007	8	4	LUG: SOLDER #10	78189	2501-10-00
	0360-0042	8	2	LUG: SOLDER 90°	78189	OBD
	2260-0001		4	NUT: HEX 4-40 X 1/4 IN.	28480	2260-0001
	2420-0001	0	4	NUT: HEX 6-32 X 5/16 IN. W/LOCK	78553	
	2820-0001	5	3	NUT: HEX 10-32 X 3/8 IN.	73734	OBD
	2950-0006	5	3	NUT: HEX 1/4-32 X 3/8 IN.	73734	9000
	2950-0001	5	3	NUT: HEX 3/8-32 X 1/2 IN.	73734	OBD
	2950-0037	0	1	NUT: HEX 1/2-16 X 11/16 IN.	78553	C6800-632-248
	2950-0038	5	1	NUT: HEX 1/2-24 X 11/16 IN.	75915	903-12
	0590-0039	0	4	NUT: SPEED 6-32	78553	C6800-632-1
	0590-0052	0	2	NUT: SPEED 6-32	78553	CB820-632-4
	410C-41A		1	PLATE: INSULATOR (USED WITH A1S1 AND A2S2)	28480	410C-41A
	0340-0580		1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0580
	1251-0209	5	1	PLUG: TELEPHONE (P/O 11036A)	82389	2P-1297
	00410-42101		1	PROBE: CONTACT BODY (P/O 11036A)	28480	00410-42101
	00410-42102		1	PROBE HEAD (P/O 11036A)	28480	00410-42102
	4108-21F		1	RING: RETAINER (P/O 11036A)	28480	4108-21F
	2200-0006	5	2	SCREW: MACHINE 4-40 X 3/8 IN RH	73734	OBD
	2200-0014	5	2	SCREW: MACHINE 4-40 X 9/16 IN RH	73734	OBD
	2370-0001	5	20	SCREW: MACHINE 6-32 X 1/4 IN. RH	73734	OBD
	2390-0007	5	4	SCREW: MACHINE 6-32 X 5/16 IN BH W/LOCK	73734	OBD
	2370-0002	5	8	SCREW: MACHINE 6-32 X 3/8 IN FH	73734	OBD
	2370-0003	5	2	SCREW: MACHINE 6-32 X 1/2 IN FH	73734	OBD
	4108-21E		1	SLEEVE (P/O 11036A)	28480	4108-21E
	1460-0006	0	1	SPRING: DIODE CONTACT (P/O 11036A)	91260	OBD
	1490-0031	0	1	STAND: TILT	91260	OBD

See introduction to this section for ordering information
*Indicates factory selected value

Tabla 6-3. Raplacaabla Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
	410C-66A		2	SUPPORT: CIRCUIT BOARD (USED WITH A3)	28480	410C-66A
	410C-21D		1	TEST LEAD ASSEMBLY: COM	28480	410C-21D
	410C-21C		1	TEST LEAD ASSEMBLY: DCA - OHMS	28480	410C-21C
	410C-21A		1	TEST LEAD ASSEMBLY: DCV (INCLUDES R1)	28480	410C-21A
	5020-6852		1	TRIM: METER	28480	5020-6852
	11036-62101		1	TUBE: SOCKET AND CABLE ASSEMBLY (P/O 11036A)	28480	11036-62101
	3050-0066	5	2	WASHER: FLAT #6	73734	080
	3050-0067	5	3	WASHER: FLAT 3/8 IN. ID	73734	080
	0900-0016	3	1	O-RING: FUSE HOLDER	83259	2-112-N674-70
	2190-0005	8	2	WASHER: LOCK #4 EXTERNAL	78189	080
	2190-0004	8	2	WASHER: LOCK #4 INTERNAL	78189	SF1904
	2190-0003	8	2	WASHER: LOCK #4 SPLIT	78189	080
	2190-0047	8	30	WASHER: LOCK #6 COUNTERSUNK	78189	080
	2190-0021	8	2	WASHER: LOCK #10 INTERNAL	78189	1910
	2190-0028	8	2	WASHER: LOCK #10 INT/EXT	78189	4010-18-00
	2190-0027	8	3	WASHER: LOCK 1/4 IN INTERNAL	78189	1914
	2190-0022	8	4	WASHER: LOCK 3/8 IN ID	78189	1920
	2190-0037	8	2	WASHER: LOCK 1/2 IN INTERNAL	78189	1224-08
	1400-0090	5	1	WASHER: NEOPRENE	75915	901-2
	2580-0004		1	NUT-HEX-W/LKWR 8-32-THD	00000	ORDER BY DESCRIPTION
	0360-0014		1	BARRIER BLOCK 2-TERM GAI PHEN	28480	0360-0014
	00410-00222		1	PANEL: REAR	28480	00410-00222
	00410-00221		1	PANEL: FRONT	28480	00410-00221
	00410-01213		1	BRACKET: CONNECTOR (USED WITH A3 CONNECTOR)	28480	00410-01213
	8150-0022		1	WIRE: RED 5 IN	28480	8150-0022
	8150-0037		1	WIRE: WHITE/RED 5 IN	28480	8150-0037
	8150-0036		1	WIRE: WHITE/ORANGE 5 IN	28480	8150-0036
	8150-0040		1	WIRE: YELLOW/WHITE 5 IN	28480	8150-0040
	0370-1095		1	KNOB-BASE 1/2 OBP .25-IN-ID	28480	0370-1095
	2190-0022		1	WASHER: LK INTL T 3/8 IN	28480	2190-0022
	2950-0001		2	NUT-HEX-OBL-CHAM 3/8-32-THD	00000	ORDER BY DESCRIPTION
	2110-0564	9	1	FUSEHOLDER BODY 12A MAX FOR UL	06328	031.1651
	2110-0565		1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
	2110-0569		1	FUSEHOLDER NUT 12A MAX FOR UL	28480	2110-0569
	1400-0090		1	FUSEHOLDER COMPONENT FOR USE ON	28480	1400-0090

See introduction to this section for ordering information
*Indicates factory selected value

Reorder No. or
Manual Part No.
00410-90009-E0381